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Supply and Irrigation Paper No. 122

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

tion of the Law to Underground Waters

BY

DOUGLAS WILSON JOHNSON

WASHINGTON

GOVERNMENT PRINTING OFFICE

1905

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CONTENTS.

	Page.
LETTER OF TRANSMITTAL	5
INTRODUCTION	7
Abbreviations used	7
CHAPTER I. Common-law rules concerning underground waters	9
Definition of underground waters	9
Classification of underground waters	9
Underground waters of the first class	10
What constitutes underground waters of the first class	10
Laws relating to underground waters of the first class	11
Underground waters of the second class	12
Laws relating to underground waters of the second class	12
General principles	12
Interference with wells	14
Interference with springs	17
Interference with streams	18
Injury to land	19
Damming of underground waters	21
Disposal of intercepted underground waters	21
Artificial production of percolation	22
Artificially increased percolation	23
Pollution of underground waters	25
Effect of motive	28
Effect of grant or agreement	30
Effect of prescription	31
Summary and conclusions	32
CHAPTER II. Legislative acts affecting underground waters	39
Introduction	39
California	39
Colorado	40
Idaho	41
Michigan	42
Nebraska	42
Nevada	43
New Jersey	43
New Mexico	44
Oklahoma	44
Oregon	44
South Dakota	45
Utah	48
Washington	48
Wisconsin	49
Wyoming	49
INDEX	51

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., February 23, 1905.

SIR: I have the honor to transmit herewith a manuscript entitled "Relation of the Law to Underground Waters," prepared by Douglas Wilson Johnson at the request of Mr. M. L. Fuller, in charge of the eastern section of the division of hydrology, and recommend that it be published as a water-supply and irrigation paper.

This manuscript, which is the first comprehensive paper prepared in this country on the relation of the law to underground waters, was compiled to meet a considerable and ever-increasing demand for information as to the application of the law to this subject. It is especially pertinent at this time, when active efforts are being made in several States to enact laws governing the use of underground waters which shall take account of the recent advances in the science of hydrology and the present knowledge of the occurrence and movements of such waters.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

RELATION OF THE LAW TO UNDERGROUND WATERS.

By Douglas Wilson Johnson.

INTRODUCTION.

The following pages represent an attempt to outline the main features of the laws respecting underground waters, with the object of giving to the owner of such waters some idea of his rights and obligations concerning them. It is needless to say that the report is in no sense a legal treatise, but rather an endeavor to collect and arrange such legal decisions as will serve to show the relation of the law to problems which are essentially geological in character. In summing up the general features of this law, I have recorded some observations which present themselves to the student of geology.

Throughout the preparation of the paper I have received much help from such authoritative works as John M. Gould's treatise on the "Law of Waters," Pomeroy's treatise on "Water Rights," the section of the American and English Encyclopædia of Law dealing with "Underground Waters," and the Lawyer's Reports Annotated. The original reports of all the cases here cited, as well as of many others, have been consulted in the endeavor to ascertain just what were the critical points upon which each was decided. I am indebted to Prof. John C. Gray, of the Harvard Law School, and Mr. George Albert Walker, of the Boston bar, for valuable criticism.

ABBREVIATIONS USED.

Allen (Mass.)=Allen's Massachusetts Reports.
Am. Dec.=American Decisions.
Am. Law Reg.=American Law Register.
App. Cas.=Appeal Cases, English Law Reports.
B. & S.=Best and Smith's English Queen's Bench Reports.
Barb.=Barbour's Supreme Court Reports, New York.
Beav.=Beavan's English Rolls Court Reports.
Cal.=California Reports.
Cent. Rep.=Central Reporter.
Ch. Div.=Chancery Division, English Law Reports.
Conn.=Connecticut Reports.

Ct. of Cl.=Court of Claims, United States.

Cush. (Mass.)=Cushing's Massachusetts Reports.

El. & Bl.=Ellis and Blackburn's English Queen's Bench Reports.

El. & El.=Ellis and Ellis's English Queen's Bench Reports.

Enc.=American and English Encyclopædia of Law, vol. 27, "Underground Waters," pp. 423–444.

Exch.=Exchequer Reports (Welsby, Hurlstone, and Gordon).

Gould="A Treatise on the Law of Waters," third edition, by John M. Gould, Ph. D., Chicago, 1900.

H. &. N.=Hurlstone and Norman's English Exchequer Reports.

H. L. Cas.=House of Lords' Cases.

Hun=Hun's New York Supreme Court Reports.

Ill.=Illinois Reports.

Ind.=Indiana Reports.

Iowa=Iowa Reports.

Jones' Eq.=Jones's North Carolina Equity Reports.

Ky.=Kentucky Reports.

L.=Laws (legislative acts of States and Territories).

L. R. A.=Lawyer's Reports Annotated, Rochester, N. Y. (Lawyers' Cooperative Publishing Company).

L. R. C. P.=English Law Reports, Common Pleas.

L. R. Ch.=English Law Reports, Chancery, Appeal Cases.

L. R. H. L.=English Law Reports, English and Irish Appeal Cases.

L. R. P. C.=English Law Reports, Privy Council, Appeal Cases.

L. T. N. S.=Law Times Reports, New Series.

M. & W.=Meeson and Welsby's English Exchequer Reports.

Mass.=Massachusetts Reports.

Me.=Maine Reports.

Mich.=Michigan Reports.

N. Car.=North Carolina Reports.

N. H.=New Hampshire Reports.

N. Y.=New York Reports.

Nev.=Nevada Reports.

Ohio St.=Ohio State Reports.

Pac. Rep.=Pacific Reporter.

Penn. St.=Pennsylvania State Reports.

Pick.=Pickering's Massachusetts Reports.

Pomeroy="A Treatise on the Law of Water Rights," by John Norton Pomeroy, LL. D., and Henry Campbell Black, M. A., St. Paul, 1893.

Vt.=Vermont Reports.

CHAPTER I.

COMMON-LAW RULES CONCERNING UNDERGROUND WATERS.

Of the water which falls upon the earth in the form of rain one portion suffers evaporation, a second portion escapes by direct run-off into surface streams, while a third portion sinks into the ground. The second portion, or that which escapes into surface streams, may find its way directly to the sea, with some loss by evaporation; or it may happen that an appreciable portion of this water will later sink below the surface and pursue for some time a subterranean course. The third portion, or that which at first passes directly into the ground, may later emerge to join surface streams, or may find its way to the sea without ever reappearing at the surface. During the course of its journey underground, water may collect into more or less well-defined subterranean channels, or may pass through the general mass of porous earth by slow percolation.

DEFINITION OF UNDERGROUND WATERS.

It will be seen, then, that underground waters comprise all waters which are for the time being below the surface of the ground, whether they have reached their present position by penetrating the ground directly after the fall of rain, or by escape from such surface bodies of water as springs, swamps, lakes, rivers, etc.; whether they are confined to definite channels, or are dissipated throughout the mass of more or less porous ground; and whether they are ultimately to reach the sea without reappearing at the surface, or are soon to emerge as well-defined streams or numerous widely distributed springs.

CLASSIFICATION OF UNDERGROUND WATERS.

While recognizing the broad definition of underground waters given above, the law divides such waters into two distinct classes, and provides for each a different rule. This division is based on the method of transmission underground—whether in definite channels or by general percolation. It is evident that in many cases it would be impossible to know whether or not such underground transmission were in definite channels; and hence the law provides that where doubt exists the presumption shall be in favor of the ordinary percolation of water through the ground. Thus limited the law recog-

nizes the two following classes of underground waters: (1) Underground currents of water flowing in defined and known channels; (2) water passing through the ground beneath the surface, either without definite channels or in courses which are unknown.

UNDERGROUND WATERS OF THE FIRST CLASS.

(Underground Waters Flowing in Defined and Known Channels.)

WHAT CONSTITUTES UNDERGROUND WATERS OF THE FIRST CLASS.

The meaning of "defined and known" as here used is thus explained by Gould (558): "In this connection, 'defined' means a contracted and bounded channel, though the course of the stream may be undefined by human knowledge, and 'known,' which is not here synonymous with 'visible,' refers to knowledge by reasonable inference." When the water flows in an underground channel which could be ascertained only by excavations, such a channel is not considered as "known."

In order to be certain that a given subterranean flow comes within the scope of this class of underground waters, one must be able to show, without opening the ground by excavation, that the water flows in a definite channel. For example, it is sufficient for this purpose if one can show that a continuous stream channel exists, and that the water which disappears beneath sand and gravel in the bed of this channel at one point reappears farther downstream. This is often the case with streams in arid regions, whose waters appear at the surface only at occasional points along a channel which can be readily and continuously traced. In the case of Case *v.* Hoffman (L. R. A. 20, p. 40) it was held that "The flowing of water upon and beneath the surface of lands between a natural lake * * * and a creek into which they discharge constitutes a watercourse where the flow is all in the same direction and a part of the way along a distinct and plainly marked channel, although for some of the distance it spreads over wide reaches of marsh and swamp lands, and percolates the soil in many and most places between the lake and the creek."

If a stream flows into a sinkhole in a definite direction, pursues for a short space a subterranean course, and then emerges on the surface again, it is considered to have a definite and known channel. Even where a large stream pursues a subterranean course for a great distance, it comes within this class if it is shown to be a watercourse in the proper sense of the term. It has also been held that a subterranean stream has a well-defined channel where its course is marked by certain vegetation which would grow nowhere except above such subterranean stream. It would seem that the presence of sinkholes or depressions, the structural relations of hard and easily soluble

rocks, and other geological factors might often be of great importance in helping to establish the existence and direction of subterranean channels. And while it is not essential that the exact course of a subterranean channel be known in order to establish its existence, a knowledge of that course forms an important addition to the evidence.

It is not sufficient to show that a certain portion of water passes underground from one place to another, since that water, even though it travel in a definite direction, may reach its destination either by percolation through the more or less porous ground or by passage through definite channels. Thus, in a case where the flow of water from a spring was stopped when the water was drained out of a natural basin on higher ground, it was held that the mere fact that the spring was supplied from the basin was insufficient to show that the water flowed from basin to spring in a well-defined channel. In like manner it is probable that the transmission of coloring matter from one point to another by underground water would hardly be regarded as evidence of the existence of a definite channel, although the transmission of particles of material size, such as fragments of wood, might be considered more significant.

Where there is nothing to show that the waters in their subterranean courses are confined to definite and known channels, they are presumed to be transmitted by ordinary percolations through the ground, and so to belong to the second of the two classes of underground waters, as defined above.

LAWS RELATING TO UNDERGROUND WATERS OF THE FIRST CLASS.

In the conception of the law all those underground waters which have a definite and known channel are to be dealt with as if they were surface streams, and no distinction is made between such subterranean and surface waters because of their location. Accordingly, the laws applicable to this first class of underground waters are the same as those which apply to streams on the surface of the ground.

It is beyond the limits of this paper to enter into a discussion of the relations of the law to surface waters, but a few of the general principles upon which that law rests may be here referred to in order that the rules governing the use of underground waters of the second class may be better appreciated. Perhaps the most fundamental distinction is that the law recognizes only certain rights in the waters of surface streams (including, as we have seen, underground streams with definite and known channels), whereas it admits absolute ownership in subterranean percolating waters. The right in the waters of surface streams is, in general, the right to have the water flow through one's land in its natural state, through its accustomed channel, and without material diminution in quantity or deterioration in quality. From this it follows that, in general, one may not

consume all the water of a stream, although he may appropriate a reasonable portion for his use, provided this right is exercised with due regard to the rights of other proprietors above and below him. He may, however, consume what water is required for necessary uses, even if he renders the stream dry. He may not divert a stream so as to cause it to flow onto the land of his neighbor below in a new channel, although he may divert the stream on his own land, provided he return it to its accustomed channel without material loss before it leaves his property. He may not build a dam which will force the water back upon the land of his neighbor above.

While this is the general attitude of the law toward surface streams and underground waters of the first class, there are many exceptions. Thus, in a Massachusetts decision, it has been held that the proprietor who first builds a dam for reasonable purposes has a right to maintain it, even though it forces the water back upon the land of his neighbor upstream to such an extent as to prevent the latter from having sufficient fall to erect a mill on his land, while his downstream neighbor would not be allowed to build a dam which would raise the water so far as to stop the wheel of the first proprietor's mill. Such a right is generally given by special mill acts. This rule has been repudiated in certain other States, or else made conditional on certain other legal rights. (Pomeroy, pp. 13-15.)

The greatest exceptions, however, are to be found in the Pacific and Rocky Mountain States, where the needs of mining, customs arising in mining camps, etc., have led to the establishment of the law of "prior appropriation," by which the one who first appropriates a stream is entitled to divert, use, and consume such quantity of water from the stream as is necessary for his mining operations; and he becomes absolute owner of such water as is thus appropriated. This doctrine has been extended to all other beneficial purposes for which water is essential, such as milling, manufacturing, agriculture, irrigation, and municipal purposes. (Pomeroy, pp. 19-20; Gould, p. 451 et seq.)

UNDERGROUND WATERS OF THE SECOND CLASS.

(Water passing through the ground below the surface, either without a definite channel or in courses which are unknown.)

LAWS RELATING TO UNDERGROUND WATERS OF THE SECOND CLASS.

GENERAL PRINCIPLES.

The relation of the law to underground waters of the second class, or underground waters proper, constitutes the subject of this paper. It is to be remarked at the outset that the mutual rights and obligations of neighboring proprietors regarding surface streams (includ-

ing the first class of underground waters), which have been briefly referred to above, have no application to waters of this second class, which are, or must be presumed to be, ordinary percolations through the general mass of more or less porous ground. The fundamental principle upon which the laws regulating the use of these waters are based is this: That such percolating subterranean waters are a part of the land itself, and belong absolutely to the proprietor within whose territory they are. The land belongs to the owner, whether it be solid rock, porous ground, entirely earthy matter, or part soil and part water. The percolating waters within his territory are as truly his absolute property as are the rocks, ores, or minerals. Consequently he may take and use such waters as he pleases, although such use may cause damage to his neighbor.

From this it follows that one may withdraw from his soil all the percolating water he desires; and since it is manifestly impossible to say how much of such water was originally within the limits of his own territory, how much comes into his territory from that of his neighbors, or how much passes from his own territory into that of his neighbors, it is held that he may completely abstract all such waters from his own soil, even though in so doing he also abstracts the water from the soil of neighboring proprietors. In like manner, one may obstruct or interfere with the natural flow of underground waters of this class or change the course of such flow in any way he may choose.

There are several conditions which have resulted in the development of such a body of law. The courses of such waters as are embraced in this class being "indefinite and unknown," it has been believed that any other rule would hold a man responsible for the preservation of rights which he could not appreciate until after such rights had been violated. Not until his own well was completed could he know that it would abstract the water from his neighbor's well. Not until his own mine excavation was made could he tell that farming land miles away would be drained of its water. "One can hardly have rights upon another's land which are imperceptible."

It has also been pointed out (Tindal, C. J., in Acton *v.* Blundell, 12 M. & W., p. 350) that no one knows what changes these underground waters undergo; that perhaps only a day ago the course taken by such waters became what it is to-day. The sinking of any well may completely alter the direction of percolation over a given area; and the proprietor can not be held responsible for such changes as may benefit or damage his neighbor, but concerning which neither of them can have any knowledge until after the change is effected.

Any other rule, it is argued, would place an unbearable responsibility upon the proprietor, for in the proper use of one's own land it has happened that the waters have been drained from land several

miles away. The ordinary work of mining may so drain the water from the soil that destruction of crops, failure of streams, and even cave-ins will result at great distances from the mine. To hold the proprietor responsible for such unforeseen results of his legitimate pursuits would necessarily greatly interfere with beneficial occupations of various kinds. Such is the idea expressed by Lewis, C. J., when he says: "No man could dig a cellar or a well, or build a house on his own land, because these operations necessarily interrupt the filtrations through the earth. Nor could he cut down the forest and clear his land for the purposes of husbandry, because the evaporation which would be caused by exposing the soil to the sun and air would inevitably diminish, to some extent, the supply of water which would otherwise filter through it. He could not even turn a furrow for agricultural purposes, because this would partially produce the same result." (Wheatley *v.* Baugh, 25 Penn. St., p. 532.)

This whole matter has been summed up by one authority in the following words: "The law recognizes no correlative rights in respect to underground waters percolating, oozing, or filtrating through the earth, and this mainly from considerations of public policy—(1) Because the existence, origin, movement, and course of such waters, and the causes which govern and direct their movements are so secret, occult, and concealed that an attempt to administer any set of legal rules in respect to them would be involved in hopeless uncertainty, and would be, therefore, practically impossible. (2) Because any such recognition of correlative rights would interfere, to the material detriment of the Commonwealth, with drainage and agriculture, mining, the construction of highways and railroads, with sanitary regulations, building, and the general progress of improvement in works of embellishment and utility." (Brinkerhoff, J., in Frazier *v.* Brown, 12 Ohio St., p. 311.)

With the above brief reference to the general principles upon which the law relative to underground waters of the second class is based, attention will now be given to the application of this law to more concrete cases, exceptions to the general rules being noted, and the opinions in accordance with which typical cases have been decided quoted to such an extent as may serve to make the matter clear.

Throughout the following pages it should be borne in mind that "subterranean" or "underground" waters, as here used, refers always to the second class of underground waters—those which are, or must be presumed to be, the result of ordinary percolation through the general mass of the ground.

INTERFERENCE WITH WELLS.

It is known that where one well has been successfully supplying water for a time, and then a second well is driven in greater or less

proximity to the first, the result may be to diminish the supply of water available from the first well, or even to stop that supply entirely. This matter of "well interference" has received considerable attention from students of the problem, and it is known that the closeness with which wells may be placed without expecting serious interference depends upon several factors, among which is the manner of their disposition with regard to the direction of the movement of underground waters.

The right of a proprietor to interfere with the supply of his neighbor's well by driving a well on his own land is upheld by an almost unbroken line of legal authority. The only redress which the other has is to sink his well deeper, and the geological conditions may be such that even this will afford him no relief. A proprietor has a perfect right to dig his well and by means of it to draw off all the water from his own land which would otherwise pass to his neighbor, and also to draw off all the water coming from his neighbor's land, even if the result be to make the neighbor's well entirely dry. Or a proprietor may interfere with his neighbor's well by any other use of his own property, as by digging ditches, excavating mines or quarries, or obstructing in any way the natural flow of underground waters.

Thus, in a case where a mill was run by water raised from a well, and the sinking of a coal pit half a mile distant drew off the supply of water from the well, it was held that the damage to the mill owner was not a legal injury, and that there was no redress for him at law. (Acton *v.* Blundell, 12 M. & W., p. 324.) In like manner in a case where the construction of a sewer or drain by one party prevented water from flowing to the well of another and abstracted from the well water which had already found its way there, it was held that the party whose well was thus damaged had no legal redress. (New River Co. *v.* Johnson, 2 El. & El., pp. 434–446.) "It makes no difference whether the damage arise by the water percolating away, so that it ceases to flow along channels through which it previously found its way to the spring or well, or whether, having found its way to the spring or well, it ceases to be retained there." (Ballacorkish Mining Co. *v.* Dumball, 29 L. T. N. S., p. 659.)

A notable exception to the above rule is presented by certain New Hampshire cases, where it has been held that a proprietor must make such use of his land as is reasonable if he wishes to escape liability for damage caused to his neighbor's well. The court has expressed its opinion in one such case, as follows: "We do not think it follows * * * that a landowner has the full and unlimited ownership and the absolute and unqualified right of control of all water in or upon his land not gathered into natural watercourses; for the nonexistence of an absolute right does not conclusively disprove the existence of a qualified right. * * * Any interference by one landowner, with

the natural drainage, injurious to land of another and not reasonable is unjustifiable." (Bartlett, J., in Bassett *v.* Salisbury Mfg. Co., 43 N. H., pp. 573–574, 577; 82 Am. Dec., pp. 180, 185.) This principle, that the absolute ownership of percolating waters is to be qualified by requiring a reasonable use of such waters, has been adhered to in other cases. Thus in an Iowa case (Willis *v.* Perry, see L. R. A. 26, p. 124), a city made several wells and pumped much water from them, thereby depriving a woman of water which she was accustomed to secure from her well. The city was held liable for damages on the ground that its use of the water was not reasonable. It was also held that the reasonableness of the use did not depend upon the city's needs or wants, but should be determined in view of the number of well owners and their respective wants.

A second exception to the rule is formed by an important California case (Katz *v.* Walkinshaw, 141 Cal., p. 116), referred to in more detail under the heading "Injury to land" (pp. 20–21), where it was held that the owner of one artesian well had no right to withdraw percolating water for the purpose of carrying it to distant lands for sale when such action decreased the supply of his neighbor's well to the irreparable injury of the latter. This decision will probably form a precedent in other irrigation States where artesian water is necessary for agricultural purposes.

Another apparent exception to the general rule is to be found in those cases where a corporation or similar body, having secured control of certain land, makes such use of that land as to damage the well of a neighboring landowner, the corporation being required to pay damages in such cases. This apparent exception is to be reconciled on the ground that the corporation does not secure absolute ownership of the land, but merely purchases certain rights in that land, or else is required by the empowering statute to pay all damages resulting to property not its own. Thus, in a case where excavations by a railroad company within its right of way resulted in damage to the well of a neighboring proprietor the company was held liable for the damage, on the ground that it did not own the land, but had only acquired a special right in the land on the condition of paying all damages which might be thereby occasioned to others. (Parker *v.* Boston and Maine R. R., 3 Cush. (Mass.), pp. 109, 114.) In a case where a corporation was sinking a ditch and well and erecting a pump to get water for its customers, on land held by a private party in fee but taken by the corporation under a statute, and it was shown that the result would be to injure the water rights on adjoining land owned by the same private party, an injunction was granted against the corporation (Hart *v.* Jamaica Pond Aqueduct Co., 133 Mass., p. 488); and where a town constructed a sewer upon land taken for that purpose, thereby draining wells fed by percolation through soil on

ken and not adjoining land taken, it was held liable for the
the ground that it was not owner of the land. (Trow-
brookline, 144 Mass., pp. 139, 141–142.)
other hand, when it is considered that the corporation or
ly has become absolute owner of the land, the usual rule
d no damages can be recovered in case a well is injured by
which such corporation may choose to put its land. Thus
held that a city is not liable for damage resulting from the
n of a sewer. (Elster *v.* Springfield, 49 Ohio St., p. 82
Where the water was wholly abstracted from a well as a
e construction of the Washington water tunnel, authorized
of Congress, it was held that the damage was not a legal
ce the United States had a clear title to the property.
r *v.* U. S., 25 Ct. Cls., pp. 87–97.)
id company was not held responsible for injury to a spring
here it had acquired the "right of way over and through
or all purposes connected with the construction, use, and
of its railway." (Hougan *v.* Milwaukee and St. Paul
35 Iowa, p. 558.) It has been held that a railroad com-
he purpose of constructing its road, has the same right to
ithin the limits of its right of way that a private individual
upon his land for any purpose, and that one whose well is
ry as a result of such excavation can have no legal redress.
ny and Salem R. R. Co. *v.* Peterson, 14 Ind., 112, 114; 77
pp. 60, 62.)
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such use of that land as he may desire, whether such use is
or not being generally held immaterial, and that any
ich such use may cause to a neighbor's well is not a legal

INTERFERENCE WITH SPRINGS.

s of law applicable to interference with wells apply in gen-
qual force to interference with springs. It is usually held
rietor may make such use of his land as he desires, although
ay cause the water in his neighbor's spring to diminish or
appear. Thus, in a case where large springs on a land-
operty were destroyed by excavations made by a metro-
ard of works for a sewer, it was held that no damages
ollected. (Regina *v.* Metropolitan Board of Works, 3
708.) Where a spring was fed solely from percolating
n a swamp on wet land around it, and not by any running
was held that no damages could be recovered against one
ed the waters by means of a tunnel and ditch constructed

on his own land. (So. Pac. R. R. Co. *v.* Dufour, 95 Cal., p. 615; 30 Pac. Rep., p. 783.)

In a like manner it has been held in a Vermont case that "a grant of a spring does not by implication convey percolating water before it reaches the spring." (Wheelock *v.* Jacobs, 70 Vt., p. 162.) A spring destroyed by mining operations is not a subject of legal redress in case the ground itself is properly supported. (Gumbert *v.* Kilgore, 6 Cent. Rep., p. 406.) If the ground itself is improperly supported, however, and a spring is injured in consequence, damages may be collected. In general, also, a city is not responsible because a sewer constructed by it drains away the percolating waters which formerly supplied a spring. (Elster *v.* Springfield, 49 Ohio St., p. 82.)

But there are exceptions to the above general ruling of the courts. It has been held, for instance, that "where a stream, from time immemorial, has flowed through plaintiff's land in a perceptible current and in a well-defined channel, his right to have such flow continued is not affected by the fact that the source of the stream is a spring on defendant's land." (Pomeroy, p. 176; Chauvet *v.* Hill, 93 Cal., pp. 407–410; 28 Pac. Rep., pp. 1066–1067.)

The question of reasonableness of use has been emphasized in some cases, as, for instance, where a person dug a trench and placed a tile pipe in such manner as to abstract percolating water which supplied a spring and to conduct it into a sewer. It was held that the person had no right to collect or divert percolating water for the sole purpose of wasting it. (Stillwater Water Co. *v.* Farmer, see L. R. A. 60, p. 875.) "Even a railroad corporation armed by law with the eminent domain, and having power to take private property for the construction of its road, is answerable to the owner of a spring for destroying it, although its destruction be caused by excavations on the land of an adjacent proprietor." (Lewis, C. J., in Wheatley *v.* Baugh, 25 Penn. St., p 533.) As in the case of well interference, discussed above, this last may be only an apparent exception to the rule, and in general is to be reconciled on the ground that the railroad company is not absolute owner of the land, but merely acquires certain rights therein, or is required by statute to pay compensating damages.

INTERFERENCE WITH STREAMS.

According to the law of surface waters a landowner is entitled to have a surface stream flow through his land in its natural condition without material diminution in quantity. But such streams are often fed largely, either directly or indirectly, by percolating waters. This brings about an inevitable conflict between the laws of surface and subterranean waters, for according to the one a proprietor can not do anything which will diminish the volume of the stream flowing through his neighbor's land, while according to the other he has a

perfect right to the percolating waters which supply that stream, even though by using such waters he may diminish the volume of the stream. Conflicting decisions have been the result of such a condition.

The decisions of many authorities are on the side of the application of the laws relating to subterranean waters, according to which the one who suffers as a result of the diminished volume of the stream has no recourse against the one who caused the damage. Thus, in a case where a mill which had been propelled for more than sixty years by a stream was retarded because the stream was diminished in volume as a result of the sinking of a well which abstracted a great amount of the percolating waters which fed the stream, it was held that the damage was not a legal injury. (Chasemore *v.* Richards, 7 H. L. Cas., p. 349; 2 H. & N., p. 168; 5 H. & N., p. 982.) It has likewise been held in California that the fact that a party is entitled to the water of a stream which is fed by a spring can not prevent the owner of the land from digging ditches for a useful purpose and thereby diverting the percolating waters which supply the spring. (So. Pac. R. R. Co. *v.* Dufour, 95 Cal., pp. 619–620.)

On the contrary, in another case where parties sunk a well on their own property, thus preventing water from percolating in its natural course into a stream upon which another's mills were situated, resulting in damage to the running of the mills, it was held that the parties causing the damage were liable for it. (Dickinson *v.* Grand Junction Canal Co., 7 Exch., p. 282.) So also it has been held that "the draining of the underground sources of a surface stream by pumping water from wells to supply a city reservoir renders the city liable to the owner of the land through which the stream naturally flows, although the city is the owner of the land on which the wells are located." (Smith *v.* Brooklyn, 160 N. Y., p. 357.) In another case similar to the above, where the defense was made that the defendant had only intercepted underground waters before they reached the stream, the defense was held to be insufficient. In Nevada it has been held that where a stream is fed by springs, but the water in passing from such springs to the stream takes a course underground which is not well understood or defined, one can not lawfully cause damage to a prior appropriator on the stream by gaining control of the water from the springs on the ground of a right to take subterranean and percolating waters. (Strait *v.* Brown, 16 Nev., pp. 317–324.)

INJURY TO LAND.

The damage caused by withdrawing subterranean waters is not wholly restricted to interference with the natural conditions of wells, springs, and streams. It may happen that the withdrawal of such waters will result in a sinking or caving in of a neighbor's land or in the destruction of his crops. On the general principle that a man is

absolute owner of the subterranean percolations within his territory and may do as he pleases with them, and because it is held that a man has no legal right to the support of underground water, it has been decided that where a landowner withdraws so much of such water as to cause a subsidence of the land in his neighbor's territory or an injury to his crops, he is not responsible for the damage. So, also while a man entitled to take minerals from a land is required to leave proper support for the surface he may drain the subterranean water from the ground, even if that results in a subsidence of the surface (See Gould, p. 565 and subjoined references.)

On the other hand, cases have been decided in the opposite way—as, for example, a certain New York case where it has been held that "The draining of land of a private proprietor by city pumping works which exhaust from all the region thereabouts the natural supply of underground or subsurface water and thus prevent the raising upon it of crops to which the land was and is peculiarly adapted, or destroy such crops after they are grown or partly grown, renders the city liable to him for the damages which he sustains and entitles him to an injunction against a continuance of the wrong." (Forbell *v.* N. Y. 164 N. Y., p. 522.) The statute of incorporation may hold a company responsible for damages in such cases.

A very important case in this connection is that of Katz *v.* Walkinshaw, decided by a California court in 1903. Parties owning land on which were growing trees, shrubs, etc., which were irrigated by percolating artesian water, brought suit to restrain another landowner from withdrawing such percolating artesian water for the purpose of conveying it to distant lands for sale, on the ground that such action diminished the water supply, to the irreparable injury of the trees, shrubs, etc. It was held that the usual rule of common law on the subject of such percolations was not to be regarded as any part of the law of California, where the arid climate brought about conditions totally different from those existing where the rule in question first sprang up. Consequently the decision of the lower court, based on that rule of common law, was reversed, and it was held that—

"Each owner of soil lying in a belt which becomes saturated with percolating water is entitled to a reasonable use thereof on his own land, notwithstanding such reasonable use may interfere with water percolation in his neighbor's soil; but he has no right to injure his neighbors by an unreasonable diversion of the water percolating in the belt for the purpose of sale or carriage to distant lands.

"The owners of artesian wells sunk in the artesian belt of percolating water, the waters of which are necessary for domestic use and irrigation of their lands, on which are growing trees, * * etc., are entitled to an injunction to restrain the diversion of the water

percolating in the artesian belt, by an owner of land situated in the belt, for the purpose of conveying the same to distant lands for sale, to the irreparable injury of the plaintiffs." (Katz *v.* Walkinshaw, 141 Cal., p. 116.)

The rule thus established for California is of far-reaching importance, and will probably form a precedent in the other States of the West where subterranean waters are necessarily relied on for irrigation purposes.

DAMMING OF UNDERGROUND WATERS.

Thus far we have been considering only such cases as involved the abstraction of underground waters. It is possible, however, to work damage to a neighbor by so obstructing the natural flow of underground water as to cause it to set back upon a neighbor's land and so flood it. Following the principle that a man may use that which belongs absolutely to him in any manner he may choose, it has been held that a landowner who obstructs underground waters within his own territory is not liable for any damage which may result to his neighbor. So in Vermont, where the owner of a mill pond raised the height of the water on his own land, thereby causing subterranean waters to set back and flood a neighbor's land, it was held that the owner of the pond was not liable for the damage caused. (Harwood *v.* Benton, 32 Vt., p. 724.)

On the other hand, in a similar case in New Hampshire, an opposite decision was rendered. (Bassett v. Salisbury Mfg. Co., 43 N. H., p. 569.) Where a miner stops up the exit from his mine into a lower mine, thereby causing the water to rise in the upper mine until it flows over into a neighbor's mine, he is not liable for the resulting damage. In some cases, however, an injunction will be granted against the one about to cause such damage. (Gould, pp. 572–573 and references.) And if one owner removes barriers by trespass, as by extending his works into his neighbor's mine, he is required to protect that mine against inundation, unless he has already been proceeded against for the trespass, and recovery had against him for it. (Gould, pp. 570–571 and references.)

DISPOSAL OF INTERCEPTED UNDERGROUND WATERS.

While a landowner is entitled to withdraw from his soil all the water he desires, even to the point of abstracting all the water from his own and his neighbor's land, having once intercepted such water for his use, he is responsible for the disposal of the same without damage to his neighbor. Having once intercepted and appropriated such water, he can not permit it to flow into his neighbor's land and effect damage there, even if it would have proceeded there and effected the damage had he not intercepted it. So a mine owner,

while he has a right to permit the water naturally flowing in his own mine to pass off by gravitation into the mine of his neighbor, provided his operations are carried on properly, yet will have no right to let such water pass off into the neighbor's mine after he has once collected or detained it for his own use.

The application of this rule to one particular case is of interest as showing the exact distinction made by the law regarding this point. Certain mine owners sunk a shaft on their property which tapped underground waters that formerly found their way into older workings on the same property, and thence into a neighbor's mine. The owners of the first property then made a borehole in the bottom of the shaft for the express purpose of letting off the water into the older workings, whence it percolated into the neighbor's mine precisely as before. The court decided that the owners of the shaft had appropriated the water, and were therefore responsible for any further damage caused by its flowing into the neighbor's mine. This seemed to be in accordance with the principle outlined above. But the case was appealed, and the former decision was reversed on the ground that the water in the shaft had not been appropriated at all, but merely altered in its course without even adding to the amount flowing into the neighbor's mine, or changing the time of its getting there. (West Cumberland Iron Co. *v.* Kenyon, 6 Ch. D., p. 773; 11 Ch. D., p. 782.) In New Hampshire it has been held that a landowner's right to alter the course of such waters is restricted to what is necessary in the reasonable use of his own property. (Gould, p. 558 and references.) In case underground water reaches the surface through an artesian well, the owner of the well may be prevented from allowing the water to flow into the streets of a city. (Skaggs *v.* Martinsville, 140 Ind., p. 476.) But in a case where water from an artesian well was allowed to flow into a natural watercourse which was "the only practicable outlet for the flow from such well," the owner of the well was held not liable to injunction. (Barnard *v.* Shirley, 135 Ind., p. 547.)

ARTIFICIAL PRODUCTION OF PERCOLATION.

While it has been held legal for a man to abstract percolating waters which are on their way to a stream or spring, or to a neighbor's well, and while he may even cause the water already in his neighbor's well to percolate out of it toward and into his own well (see preceding paragraphs), it has been held unlawful for him to construct a well or other structure near a running stream, and thus cause currents of percolating waters to develop, which would abstract water from such stream. There is thus a distinct difference between the right to take underground water before it reaches surface streams,

springs, etc., and the right to abstract water which is already a part of those surface accumulations. And since it is a principle of law that a man has no right to do indirectly that which he is not allowed to do directly, he can not take water from his neighbor's spring or stream by placing a drain or well only a few feet away, and thus letting such water run into his drain or well, when he is not allowed to take that water off directly by means of a pipe or ditch. As has been stated by one authority, "If you can not get at the underground water without touching the water in a defined surface channel I think you can not get at it at all." (Lord Hatherly, L. C., in Grand Junction Canal Co. *v.* Shugar, L. R., 6 Ch., p. 488.) Thus in a case where one proprietor constructed a drain close to a surface stream, with the result that the drain drew off the water flowing in the stream, to the damage of a neighbor, an injunction was granted preventing the unlawful act. (Grand Junction Canal Co. *v.* Shugar, L. R., 6 Ch., p. 483.) So also in a Massachusetts case it was held that "a person can not draw water from a pond by percolation if he has no right to draw it therefrom directly." (Proprietors of Mills *v.* Braintree Water Supply Co., 149 Mass., p. 478.)

It will readily appear that some difficulty must frequently be found in determining whether or not the artificial structure actually results in the abstraction of water from a surface stream or other body of surface water. The mere proximity of a well to a stream, for instance, does not prove abstraction. Neither does the diminution of water in the stream, since the well may only secure percolating water which has not yet reached the stream. The farther the well is removed from the stream, the more difficult will it be to satisfactorily establish the fact of abstraction. The party that complains of abstraction has all the burden of this proof, and must fully establish the fact that the well or other structure does draw off water from the surface accumulation before the one causing the damage will be held responsible.

ARTIFICIALLY INCREASED PERCOLATION.

It often happens that the natural percolation of a portion of soil is locally increased by various artificial means, as by the pressure of large amounts of water collected in a reservoir, or the sinking and cracking of the surface above mine excavations, thereby admitting water which would otherwise flow off into surface streams. The tendency of the law is to regard this as a "nonnatural" use of the land, and to hold the land owner responsible for any damage he may cause. In Pennsylvania a mine owner is required to leave proper support for the surface of the ground above his mine, and if he fails to do this, and the surface of the ground sinks and cracks as a result,

letting surface waters flow into his mine and from there percolate into the mine of his neighbor, he is liable for any resulting damage. (Gould, p. 572, footnote.) But in another case where a mine owner so disturbed the soil above his workings as to produce fissures in it which let the natural rainfall on the surface pass into his mine and thence by gravitation into his neighbor's mine, the mine owner causing the damage was not held liable. (Wilson *v.* Waddell, 2 App. Cas., p. 95.)

In a certain case a reservoir was constructed for accumulating water, and the contractor failed to provide sufficient support to resist the pressure of the water in certain old shafts which communicated with old coal workings, the existence of which was then unknown to the owners of the reservoir or any of those in their employ. The result was that the weight of the water caused it to break through the shafts, whence it passed through the old coal workings into a neighbor's mine. No negligence on the part of the owners of the reservoir appearing, it was held that they were not liable for the injury. This decision, however, was reversed in the higher courts, and the owners were held liable for the damage caused, since "foreign water had been sent down upon the plaintiffs, and the defendant's lack of knowledge thus became immaterial." It was held that "the person who, for his own purposes, brings on his land and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and if he does not do so, is prima facie answerable for all damage which is the natural consequence of its escape." (Rylands *v.* Fletcher, L. R., 3 H. L., pp. 330, 339, etc.) This principle has since been applied to "injuries resulting to adjoining land from the percolation of the waters of an artificial reservoir or canal through the soil; to water allowed to collect in a cellar and to percolate into the plaintiff's cellar or well adjoining; to dampness caused in the plaintiff's house by an artificial deposit near by of spongy soil and clay." (Gould, pp. 574, 575.) In a number of the States the above principle is modified to the extent that in order to hold the party liable for damage caused it must be shown that he was guilty of negligence. The principle does not apply in cases where the artificial accumulation of water was for the mutual benefit of both parties to the suit; nor where the accumulation was made for public purposes under express authority of a statute, no negligence being proven; nor where the accumulation was not made by the landowner intentionally and for his own benefit, as in the case where a house was destroyed by fire, and water collected in the uncovered cellar, thence flowing against the walls of an adjoining house built after the first house was destroyed. (Gould, pp. 575–576, and references.) In such cases no damages are recoverable.

POLLUTION OF UNDERGROUND WATERS.

The fact that a man has absolute right to the underground waters within his territory, and may abstract those waters entirely, even to the point of draining his neighbor's land, does not give him the right to poison or foul those waters and allow them to pass into his neighbor's land in such condition. Such an act is illegal, and he who causes the damage is generally held liable even if he is not guilty of negligence, "he whose filth it is being required to keep it on his premises at his peril." This is the principle laid down in the leading case of Rylands *v.* Fletcher, cited above. A marked distinction is drawn between the right to use all the underground water and so prevent its use by a neighbor, and the right to poison or contaminate that water so that when it does reach that neighbor it is unfit for use.

In a case where casks of oil stored in a warehouse leaked so that the oil entered the ground and indirectly polluted a neighboring spring. the owners of the warehouse were held liable for the damage although they were ignorant of the fact that the oil was affecting the spring. (Kinnaird *v.* Standard Oil Co., 89 Ky., p. 468.) So in a case where a man permitted sewage to flow into his neighbor's well, he was held liable for the damage, the opinion being given that "The right to foul water is not the same as the right to get it; and in my opinion does not depend on the same principles. * * * the law of nuisance is not based exclusively on rights of property." (Ballard *v.* Tomlinson, 29 Ch. Div., pp. 115, 126.)

In setting forth this same principle it has been said: "It does not follow that because I have a right to use a thing on my own land I may lawfully send it into my neighbor's premises in a condition to work an injury to him. * * * The American cases, therefore, while recognizing to its fullest extent the right of every landowner to use, detain, and even totally abstract all the underground percolating water, * * * yet quite agree with the decision * * * that he is liable for corrupting it and thus causing an injury to the well of an adjoining owner. * * * The true cause of action * * * is not exactly that the defendant contaminated underground percolating water, but that he allowed his impure sewage to escape from his premises to the plaintiff's, and the circumstances that it reached there by underground percolation instead of by a surface stream is quite immaterial." (E. H. Bennett, 24 Am. Law Reg., pp. 638, 640.)

In cases where substances from the works of a gas company have percolated into the soil, resulting in injury to a neighbor's well, the company has been held liable for the damage. In a case where it was shown that other things besides the escape of gas into the water of a well contributed to make it unfit for use, it was held that the

gas company was liable for damage to the water, although the fact that there were other sources of corruption might be shown in mitigation of the amount of damage recoverable. (Sherman *v.* Fall River Iron Works Co., 5 Allen (Mass.), p. 213.)

So when filthy water from a vault percolates through the ground and injures the cellar and well of a neighboring proprietor, the party who maintains the vault is liable for the damage. (Ball *v.* Nye, 99 Mass., p. 582.) Likewise where poorly constructed sewers permit filth to percolate from them into the cellars of adjoining premises the one who maintains such sewer is liable for resulting damages, "even if he is the owner of the premises into which the filth percolated, and the parties complaining were his own tenants." (Alston *v.* Grant, 3 El. and Bl., p. 128.)

In a case where a person polluted his own well with sewage, and the contaminated water percolated into a neighbor's well, it was claimed that the party causing the damage was not liable, since the neighbor whose well was injured secured the water from that well by artificial means—i. e., by pumping. The court held the party liable for the damage he caused, however; Brett, M. R., stating that "The plaintiff, if he has a right to use anything in nature, has a right to exercise that use by all the skill and invention of which a man is capable, and it seems to me that as long as the plaintiff uses only lawful means as against his neighbor, however ingenious or however artificial those means may be, his right to appropriate the common source is not diminished because he used the most artificial or most ingenious methods." (Ballard *v.* Tomlinson, 29 Ch. Div., p. 122.)

In cases where it can be shown that the acts of another will result in a pollution of underground waters, the courts will grant injunctions to prevent such injury. Thus a perpetual injunction was granted to restrain a party from allowing unclean refuse matter to pass from his manufactories into an old pit on his own land, since it percolated thence into a neighbor's colliery. (Turner *v.* Mirfield, 34 Beav., p. 390.) In another case a party was prevented by an injunction from using a cesspool through which water percolated into a neighboring well. (Womersley *v.* Church, 17 L. T. N. S., p. 190.) So also an injunction will be issued to prevent the establishment of a burial ground, when it can be shown that the burial of the dead there will endanger life or health by corrupting the surrounding atmosphere or the water of springs or wells. (Clark *v.* Lawrence, 6 Jones's Eq. (N. C.), p. 83; 78 Am. Dec., p. 241.) There must be clear proof of probable injury, however. It has elsewhere been held that cities have absolute authority to establish cemeteries, and discretion to judge of their necessity. (Greencastle *v.* Hazelett, 23 Ind., p. 186.) In a case where a party was about to erect a privy on his own lot, about

feet from his neighbor's house and cellar, and less than 20 feet from his well, the completion of the privy was prevented by injunction. The court, quoting another authority, said: "Privies are regarded as prima facie nuisances, and although necessary and indispensable in connection with the use of property for the ordinary purposes of habitation, yet if they are built or allowed to remain in such a condition as to annoy others in the proper enjoyment of their property by reason either of the noisome smells that arise therefrom or by the escape of filthy matter therefrom upon the premises of another, or so as to corrupt the water of a well or spring, they are nuisances in fact." (Wahle *v.* Reinbach, 76 Ill., pp. 322, 326.)

There are a few exceptions to the above rules, however, it being held in several cases that the party causing the pollution of underground water is not liable for damage caused to a neighboring proprietor unless guilty of negligence or malice. In one such case the court observes, "If withdrawing the water from one's well by an excavation on adjoining lands will give no right of action, it is difficult to understand how corrupting its waters by a proper use of the adjoining premises can be actionable, when there is no actual intent to injure and no negligence. The one act destroys the well, and the other does no more; the injury is the same in kind and degree in the two cases." (Cooley, J., in Upjohn *v.* Richland Township, 46 Mich., pp. 549, 550.)

So in a case where the operator of gas works placed obnoxious substances near a neighboring property, and portions of these substances were washed along the surface into the neighbor's well, and other portions penetrated into the ground, thus polluting the subterranean currents which supplied the well, the court held that while the operator was liable for the surface pollutions, he was not liable for any damage to the well resulting from the pollution of underground currents of water unless he acted maliciously. (Brown *v.* Illius, 27 Conn., p. 84.) In another case the party polluting underground streams whose channels and courses were unknown and undefined, was held not to be responsible for the damage caused. (Dillon *v.* Acme Oil Co., 49 Hun. (N. Y.), p. 565.) In this case a distinction was made between contaminating a subterranean stream whose channel and course were undefined and unknown, and contamination by percolation or soaking. This, also, seems contrary to the general rule of law, which makes no distinction between ordinary percolating waters, and such underground streams as have channels and courses which are indefinite and unknown.

In a case where a party sunk an artesian well upon his own land and used the water to bathe the patients in a sanitarium or hospital erected by him on his premises, and then allowed the polluted water to flow into a natural watercourse, which was the only practicable out-

let for the flow from the well, the party was held not to be liable for the resulting damages, providing he was free from negligence and malice and used due care to avoid injury to his neighbors. (Barnard *v.* Shirley, 135 Ind., p. 547.) This decision seems contrary to the general ruling of the courts in a twofold way, since it is generally held that one who intercepts and uses underground waters is responsible for their future course (pp. 21–22), and the pollution of waters is usually illegal whether or not there be malice or negligence.

The principle upon which the decisions in these exceptional cases is based seems to be that a man's obligations to preserve the purity of underground waters is limited to the reasonable and proper use of such waters, without negligence or malice on his part. According to this principle, any damage to a neighbor which is necessary and unavoidable, or not sufficiently obvious to have been foreseen, resulting from a landowner's proper and reasonable use of his land, is not held to be a legal injury.

Having now outlined the general relations of the law to the abstraction, diversion, and interruption of underground waters, and to the pollution of the same, it remains to be pointed out in what ways the general rules are modified, if at all, (1) by the motive with which the acts complained of were done; (2) by definite agreements between the parties respecting the use of the underground waters; (3) by prescription, or the long-continued use and enjoyment of such waters.

EFFECT OF MOTIVE.

Although an act may in itself be perfectly legal—as, for instance, the abstraction of underground waters from the soil, even to the point of rendering dry a neighbor's well, is generally held to be—it might be considered that a person who exercised such right with the malicious and evil intention of hurting his neighbor would be guilty of a legal injury. This question as to the effect of motive has given rise to a number of conflicting opinions.

So far as the pollution of underground waters is concerned there is little disagreement among authorities, it being generally held that, however innocently the contamination is effected, the party causing the damage is none the less liable for it. As we have seen, however, there are cases in which the party was not held responsible, provided he was guilty of no negligence and entertained no malicious motives.

In cases involving the abstraction or diversion of underground waters with malicious intent to injure a neighbor opinions have been more conflicting. The weight of authority, especially in more recent cases, is to the effect that the motive is immaterial, according to the principal that the law must deal with outward acts and not with inward motives. "When the use which a landowner makes of his property is lawful in itself, the law will not take cognizance of the motive

which prompts the use, even where it results in damage to another." (Enc., 434.) So it has been held that while "malicious motives make a bad act worse, * * * they can not make that a wrong which in its own essence is lawful." (Black, J., in Jenkins *v.* Fowler, 24 Penn. St., p. 310.) According to another authority, "Bad motives in doing an act which violates no legal right of another can not make the act a ground of action." (T. R. Strong, J., in Pickard *v.* Collins, 23 Barb. (N. Y.), p. 459.) In another case the court observes, "As an act unlawful in itself resulting in injury to another, whatever may have been the motive with which it was done, is none the less the subject of legal redress, so the act done, to wit, the using of one's own property, being lawful in itself, the motive with which it was done—whatever it may be as a matter of conscience—is in law a matter of indifference." (Brinkerhoff, J., in Frazier *v.* Brown, 12 Ohio St., p. 311-312.) So, also, in another case, "We have not given any attention to the alleged motives of the defendants. Their motives are immaterial. The question is only as to their rights." (Rodman, J., in Porter *v.* Durham, 74 N. C., p. 780.)

In accordance with the above opinions was the decision rendered in the following case: A landowner possessed a mineral spring surrounded by an artificial embankment. His neighbor dug a well on his own land, striking a vein of mineral water, evidently intimately connected with the adjacent mineral spring, and the water from this vein rose high enough to be conducted by pipes to the neighbor's bath house. Then the owner of the spring, for no purpose beneficial to himself and simply to divert the water from his neighbor's well, lowered the embankments about the spring, thereby cutting off the supply of water from the neighbor's well. It was held that the owner of the spring was not liable, the question of motive not affecting his legal right. (Phelps *v.* Nowlen, 72 N. Y., p. 39.) As stated by another authority, "It is generally held that no action will lie against one for acts done upon his own land, in the exercise of his rights of ownership, whatever the motive, if they merely deprive another of advantages or cause a loss to him, without violating any legal right; that is, the motive in such cases is immaterial." (Wells, J., in Walker *v.* Cronin, 107 Mass., p. 564.)

In striking contrast to the above are cases in which the authorities consider the motive as an important factor in the case. Thus it has been held that "neither the civil law nor the common law permits a man to be deprived of a well or spring or stream of water for the mere gratification of malice." (Lewis, C. J., in Wheatley *v.* Baugh, 25 Penn. St., p. 533.) In another case the opinion was given: "Ordinarily a landowner may dig a well upon his own land, even though, by percolation, it draws the water from his neighbor's land, or even his well; but it would present a very different question if the well was

dug by him with the express purpose of transferring the water in his neighbor's spring or well to his own, and knowing that this would be the result." (Bellows, C. J., in Swett *v.* Cutts, 50 N. H., pp. 446–447.)

According to another authority, "While a man has no right to protection against competition, he has a right to be free from malicious and wanton interference, disturbance, and annoyance." (Barrows, J., in Chesley *v.* King, 74 Me., p. 175.)

EFFECT OF GRANT OR AGREEMENT.

It seems to be well established in the courts that where one party grants certain water rights to another or makes an agreement with him regarding rights to underground waters, the parties shall be bound by the terms of the grant or agreement, and not by the rules of law applicable to underground waters in general. Thus, while in general a man may lawfully dig a well on his own land, even though he thereby drain off the water from his neighbor's well or spring, he can not do so if his act violates a grant or an agreement with that neighbor. But in cases where the act complained of does not violate any express provision of the grant or agreement, the usual rules of law are considered to apply. The following cases serve to illustrate the several phases of the question.

A party granted the surface of his land to another, but reserved the mines below. In the operation of his mines the water was all drained from the surface, thus damaging the one to whom he had made the grant. He was not held to be responsible for the damage, since he had made no express agreement regarding such waters. (Ballacorkish Mining Co. *v.* Harrison, L. R., 5 P. C., p. 49.) And where a man sells a well to another, and then by digging another well or in some other manner prevents percolating water from reaching the well he has sold, he is not liable for the damage if the sale of the well does not carry with it a guarantee of a regular supply of water. (Gould, p. 562, and references.) So, also, with a spring. "A grant of a 'certain spring or fountain of water' does not deprive the owner of the land of the right of properly draining his land to make it productive, even though in some unknown mode the drainage of the land may affect his supply of water." (Enc., p. 431, footnote and references.) In a case where one party purchased land from another with the agreement that the other should have a right to conduct water from a spring on the land thus sold to his adjoining property, and then the purchaser dug a well on the land which he had bought, destroying the spring from which he had agreed to let the other conduct water, it was held that the purchaser was not responsible for the damage, since the agreement did not entitle the other to an uninterrupted flow of the water. (Enc., p. 431, footnote and references.) Where one party granted another the right to draw water from a certain

well by a pipe laid in the ground, he was not prevented from digging another well or reservoir on his own land, thereby diverting the water which formerly percolated into the well. (Davis *v.* Spaulding, 157 Mass., p. 431.) In cases where the effect of the grant is to make the parties to it practically adjacent owners, the usual rules of law apply.

But where the terms of the grant or agreement plainly secure a regular supply of water to the one to whom such grant is made, one who interferes with underground waters so as to diminish or interrupt the supply will be held liable. Thus, in a case where a proprietor granted to a manufactory situated on his land the use of water conducted to the factory from springs on his land, and "covenanted to warrant and defend the granted premises against himself and all other persons," and then withdrew the supply from such springs, he was held liable for the damage. (Johnstown Cheese Mfg. Co. *v.* Veghte, 69 N. Y., p. 16.)

In another case a man owned two adjoining farms, on one of which was a spring from which water was conducted in pipes to the barnyard of the other. He sold this latter farm with appurtenances, but without special mention of spring and pipes. Then he dug a well near the spring, thereby lowering the water in the latter till it failed to flow through the pipes. It was held that he could be restrained from using the well causing the injury on the ground that the uninterrupted flow of water was essential to the full enjoyment of the estate conveyed. (Paine *v.* Chandler, 134 N. Y., p. 385.) This appears to be a departure from the general rule, unless "appurtenances" is interpreted as including the waters percolating into the spring on adjacent land, for in cases where the opposite decision was rendered, as noted above, the uninterrupted flow of the water was even more certainly essential to the full enjoyment of the well or spring conveyed.

When the privilege of taking water from springs of a certain locality is granted the waters can only be taken where they naturally come to the surface, not from wells or other orifices where the water does not come to the surface. (Enc., p. 431, footnote and references.)

A grant of a well or spring carries with it the right to the land immediately occupied by such well or spring. So the well is held to include "the orifice reaching down to the water, the whole opening in the earth before it is stoned, the stone laid in the wall, and the water therein." Where a spring was set apart and separated from other lands so as to extend three rods each way from the central portion covered by water, the word "spring" in a deed was held to include this land. (Gould, p. 563 and references.)

EFFECT OF PRESCRIPTION.

In law the use and enjoyment of things "from time immemorial" is held to give a legal right to certain of the things thus used and

enjoyed. This is known as the right arising from "prescription," but this right can not exist with regard to underground waters, it being held that the owner of land can not acquire by prescription the right to receive percolations through the land of another. This is clearly set forth in the following opinion: "The doctrine of prescription, presumption of grant from lapse of time, can have no proper application to the question. (1) Because the party against whom the doctrine will have to be applied could not be reasonably required to enter his caveat against the appropriation of a thing so hidden and obscure as is percolating underground water; and (2) because the appropriation of such water by an adjoining proprietor is not an infringement of his rights, so as to become the subject of legal redress, until such time as he himself has occasion to appropriate them." (Brinkerhoff, J., in Frazier *v.* Brown, 12 Ohio St., p. 311.)

SUMMARY AND CONCLUSIONS.

In summing up the generalities of the relation of the law to underground waters it is to be noted that wherever a subterranean stream can be shown to have a defined and known channel it is considered subject to the same rules of law that apply to surface streams; but where subterranean streams have channels which are indefinite and unknown, or where subterranean waters percolate through the ground independent of channels, different rules of law are applicable. Regarding the laws controlling the use of this second class of underground waters a number of points have been noted.

It has been seen that, according to a large number of decisions, a man is entitled to practically absolute control of such underground waters in his own land, but that some authorities limit him to a reasonable and proper use of such waters. The destruction of a well or spring as a result of an adjacent landowner's excavating a well, spring, cellar, mine, or ditch upon his own land is generally held to be a damage for which there is no remedy at law. But some authorities hold that in order to escape liability for such damage the party causing it must have made such use of his land as is reasonable and proper. Where the damage is caused by a corporation, as by a railroad company excavating on its right of way, damages are in general recoverable, although it has been held in some cases that such a company is no more liable for damage caused by excavations on its right of way than is a private citizen for damage resulting from excavating on his own land. It is to be noted that in the irrigation States of the West the cases are likely to be decided on different principles from those governing decisions in the East. To this effect is the California decision that "the common law rule that percolating water belongs unqualifiedly to the owner of the soil, and that he has the

absolute right to extract and sell it, is not applicable to the conditions existing in a large part of this State, where artificial irrigation is essential to agriculture, and artesian wells in percolating belts are necessarily used for that purpose." (Katz *v.* Walkinshaw, 141 Cal., p. 116.)

Where surface streams are injured by a loss in volume due to the fact that a well or other excavation on a neighbor's land intercepts the percolating waters supplying the stream, it is generally held that there is no redress for the damage, but some authorities hold that the one causing the damage is responsible for it. If a man makes a well or other excavation near a stream or other body of surface water, and thereby extracts water which has already become part of a surface accumulation, he is responsible for the resulting damage.

Where land is injured by the withdrawal of the underground water through a neighbor's well or other excavation, so that the land fails to support crops, or sinks and cracks, it is usually maintained that there is no remedy at law, although there are exceptions to this ruling. Where the obstruction of underground waters made such waters set back and overflow a neighbor's land, it was held in one case that the party causing the damage was not liable, while the opposite decision was rendered in another and similar case.

One who intercepts underground waters and appropriates them for his own benefit is in general responsible for any damage they may cause thereafter, even if the damage is the same as the waters would naturally have caused if not intercepted. But an opposite decision has been rendered in at least one such case. One who merely alters the course of percolating waters and does not appropriate them for use is not generally responsible. In one State, however, it is held that the right to alter the course of underground waters is restricted to what is necessary in the reasonable use of property.

Any one who artificially increases the natural amount of percolation is, according to some authorities, responsible for the resulting damage, but others hold that unless the damage is the result of negligence or malice no legal redress can be obtained.

The pollution of underground waters is generally held to be illegal, whatever the circumstances attending such pollution. But a few authorities maintain that such pollution is not illegal unless there is evidence of negligence or malice.

In case any of the foregoing acts, which are legal in and of themselves, is done with the express purpose of injuring a neighbor, some authorities hold that the one committing such an act with malicious motive is responsible for the damage he causes. But others, and perhaps the majority, take the position that such an one is not liable, since the motive is immaterial.

Where any of the foregoing acts, in themselves legal, violates the express terms of a grant or an agreement, the act becomes illegal.

No special right to underground waters can be acquired by long continued use and enjoyment of the same.

Such a review affords ground for careful reflection concerning the laws of underground waters. One is impressed with the great lack of agreement among authorities respecting many of the points at issue. The law of waters in general is an intricate problem, and it is not to be expected that the unsatisfactory feature referred to will ever be wholly eradicated. It is probable, however, that a better appreciation of some of the facts established within recent years by various investigations into subterranean conditions will result in more harmonious opinions, and make possible a more just administration of the laws in question.

The great lack of agreement among authorities on questions pertaining to underground waters is due in part to the nature of the problems involved. There is so much that is uncertain and indefinite in the behavior of waters hidden beneath the surface that more or less uncertainty must unavoidably attach to the laws respecting them. Perhaps the only practicable remedy is to be found in the removal, so far as it is possible, of the uncertainty and indefiniteness by an extension of our knowledge of subterranean conditions. Marked advances have already been made in this direction, and many questions may be settled to-day far more equitably than was possible a few years ago.

It is believed that a second and very important reason for the unsatisfactory condition of the law relating to underground waters is to be found in the fact that the state of our knowledge regarding such waters is now in advance of the general ruling of the court on some of the questions involved. The earlier legal decisions and authoritative opinions were made at a time when very little was known regarding that which was beneath the surface. The fundamental conception upon which many of the opinions rest is that we are ignorant of the conditions controlling waters hidden from our view. Since that time the progress of geological science has wrested from the unknown many things regarding underground waters and firmly established them in the realms of known fact. These things should serve to make possible a more equitable settlement of controversies involving rights to underground waters; and where a decision is controlled by opinions rendered in former cases, and not made with due regard to the present knowledge respecting subterranean conditions, it does not seem that a just settlement of the controversy can be reached.

That the earlier decisions and opinions serve as a guide for late

decisions is a fact known to those who are familiar with our legal procedure, and is evident on reading the decisions handed down in the various cases. Even where a certain judge was convinced from the evidence that the older decisions were manifestly wrong when applied to the case under consideration, the additional facts available in that case having thrown new light on the problem involved, nevertheless he felt compelled to decide in accordance with established precedents and against what he believed to be the right. (Collins *v.* Chartiers V. Gas Co., 131 Penn. St., pp. 159–160.) The higher courts in this instance reversed his decision. The case serves to call attention to the importance of emphasizing the influence which the ever-increasing knowledge concerning underground waters may and should have in governing legal decisions. The need of acquainting the public with such facts as are ascertained by the drilling of wells, the excavating of mines, and the investigations of public or private surveys is evident.

This point has been well appreciated by Mr. Justice Mitchell, who observed, "Geology is a progressive, and now, in many respects, a practical science, and, as truly remarked by the learned judge below, in his opinion on the motion for a new trial, 'Since the decision in Acton *v.* Blundell and Wheatley *v.* Baugh, probably more deep wells have been drilled in western Pennsylvania than had previously been dug in the entire earth in all time. And that which was then held to be necessarily unknown and merely speculative, as to the flow of water underground, has been, by experience in such cases as this, reduced almost to a certainty.' If this is the state of knowledge at the present day; if the existence of a stratum of clear water, and its flow into wells and springs of the vicinity, and the existence of a separate and deeper stratum of salt water, which is likely to rise and mingle with the fresh, when penetrated in boring for oil or gas, are known, and the means of preventing the mixing are available at reasonable expense, then, clearly, it would be a violation of the living spirit of the law not to recognize the change, and apply the settled and immutable principles of right to the altered conditions of fact." (Collins *v.* Chartiers V. Gas Co., 131 Penn. St., pp. 159–160.)

In many cases the original lack of knowledge, which was the efficient reason for the ruling of the law has already disappeared. It is sufficient for the present purpose to call attention to a few concrete instances. Thus, as stated by one authority, it has been held "that injury to springs, wells, etc., supplied by mere percolation, was not actionable, and the reason has always been the same, that the damage could not be foreseen or avoided." We are now in possession of definite knowledge concerning the amount, rate, and direction of flow of underground water in certain cases, as well as concerning the thickness of the water-bearing stratum, its depth below the surface,

and other valuable facts. In such cases it may often be possible to foretell with certainty that a given well or excavation will affect the supply of a neighboring well or spring. The damage may, therefore, be certainly foreseen. It may also be possible to show how a different position of the well would decrease the interference, or prevent it entirely, and thus avoid the damage to a greater or less extent. The damage may, therefore, be avoided in cases. The statutes of South Dakota and one or two other States recognize this possibility to foresee and prevent well interference, and make due provision for it.

So also it is now possible, in many cases, to predict with certainty what course would be taken by polluting substances carried by underground percolations, and so foretell which wells or springs would probably suffer and which would not. By noting the inclination and character of the rocks it has been possible to show that the polluted waters from a cesspool on one side of a hill would without doubt be carried down the slope of the beds, through the hill, to a spring on the opposite side. The course of such waters may in cases be demonstrated experimentally.

In one of the leading cases on this subject it was argued that "there is an absolute impossibility for anyone to know what are the underground currents, where they begin, what they produce, and in what direction they run, and consequently an absolute impossibility of knowing what are the rights in relation to them." To-day we do know, in numerous cases, what the underground currents are, where they begin, in what direction they run, and even at what rate they progress, of what volume they are, and what in general are their vertical and lateral extents. So we might now say that there is a possibility of knowing and defining what are the rights in relation to them.

According to some authorities percolating waters are to be compared with the rocks and minerals contained in the ground, and absolute ownership accorded the landowner on the same principle in both cases. Such is the idea expressed by Joseph K. Angell in his treatise on The Law of Water Courses (5th edition, pp. 110–111), in the following words: "* * * in contemplation of law, land always extends downward as well as upward; so that whatever is in a direct line between the surface of any land and the center of the earth belongs to the owner of the surface. It would consequently seem to follow that whether what is subterranean be solid rocks, mines, or porous soil, or salt springs, or part land and part water, the person who owns the surface may dig therein and apply all that is there found to his own purposes ad libitum."

It seems to me that this principle is essentially erroneous. We now know that percolating waters may and usually do possess a

definite course, that in certain cases they enter the ground at given localities which may often be determined with accuracy, that they often have a certain flow with a fairly definite velocity year in and year out, and that they exist at certain depths below the surface. It is evident, then, that such waters are not to be compared with rocks and minerals which are, as such, stationary in the soil where they occur until removed by some external power; but that they are better to be compared with those waters upon the surface which pass into the land from one direction and out of it in another, and which are not regarded as the absolute property of the landowner. Furthermore, the removal of the rocks and soil from the land of one owner does not take away the rocks and soil belonging to his neighbor: while the removal of percolating water from the land of one owner does result in taking away the percolating water belonging to that neighbor. In other words, there certainly is a common interest in the water which does not exist in the case of the rocks and soil. As has been well said by Justice Temple, "It is obvious at once that the analogy between the right to remove sand and gravel from land for sale and to remove and sell percolating water is not perfect. If we suppose a saturated plain, one may remove and sell the sand and gravel from his land without affecting or diminishing the sand and gravel from the lands of his neighbors. * * * But when he drains out and sells the water on his land he draws to his land, and also sells, water which is the property of his neighbor. * * * In short, the members of the community, in the case supposed, have a common interest in the water. It is necessary for all, and it is an anomaly in the law if one person can, for his individual profit, destroy the community and render the neighborhood uninhabitable." (Katz *v.* Walkinshaw, 141 Cal., p. 140.)

It is believed therefore that absolute ownership of percolating waters can not be properly granted to any landowner on the basis of the principles here considered; but must be granted, if at all, on the ground that our ignorance of subterranean conditions, or considerations of public policy, make such a ruling necessary. With the disappearence of the ignorance in question one of the reasons for such a law disappears, and it remains to be seen what provisions of the law, in the light of new facts, are justified by considerations of public policy.

As was pointed out at the beginning of the discussion of underground waters of the second class, some authorities justify the refusal of the common law to recognize correlative rights in respect to such waters on the ground that "the existence, origin, movement, and course of such waters, and the causes which govern and direct their movements, are so secret, occult, and concealed that an attempt to

administer any set of legal rules in respect to them would be involved in hopeless uncertainty, and would be therefore practically impossible." At the present time our knowledge of the workings of underground waters, of their origin, movement, and courses, and of the causes which govern their actions, leaves much less in the realm of the "secret, occult, and concealed." It is possible to define certain rights in these waters, and to protect those rights as well as those in surface waters. As has been recently held by a California court: "The difficulties which the courts will meet in securing persons necessarily using percolating water for irrigation by means of artesian wells, from the infliction of great wrong and injustice by its diversion, if property rights therein are recognized, can not justify the court in abandoning the task as impossible. The courts can protect this particular species of property in water as effectually as water rights of any other description." (Katz *v.* Walkinshaw, 141 Cal., p. 116.)

There yet remains much that is uncertain regarding subterranean conditions; but as, in the past, geology has added much to our store of knowledge concerning those conditions, so in the future we may confidently expect a continued increase in the known facts. And with this increase in knowledge we should look toward an increasingly satisfactory adjustment of those controversies which arise concerning subterranean waters. There probably must always be cases in which the subterranean conditions are indefinite or unknown, but the number of such cases will decrease; while it will be possible to adjust a constantly increasing proportion of the cases more equitably than was possible in the days when practically nothing was known about that which lies hidden beneath the surface of the ground.

The lack of agreement among legal authorities on many of the questions at issue is rather more fortunate than unfortunate in one respect at least, since it bears witness to the uncertain position of the law on the points involved and opens the way more readily for new knowledge bearing on the problems. Where the court is not bound by a long and unbroken line of legal authority, its decision is more apt to be in accordance with the general principles of right as applied to the present state of knowledge regarding the problem under consideration. More importance will attach to a complete and searching investigation into all the facts of the case in hand, since less will depend upon decisions rendered in similar cases years ago.

CHAPTER II.

EGISLATIVE ACTS AFFECTING UNDERGROUND WATERS.

INTRODUCTION.

It has been thought advisable to present a brief review of the more nportant legislation enacted by the different States and Territories n the subject of underground waters. No attempt has been made o gather every reference in State laws to the subject, but it is elieved the following summary will give a fairly accurate idea f the extent of such legislation and will furnish the reader with he most important provisions relating directly to the control of vaters flowing beneath the surface of the ground.

It will readily appear that most of the legislation on this subject has arisen in connection with the sinking of artesian wells for the purpose of securing underground water for domestic and mechanical purposes, and more especially for irrigation. In some of the Western States, where irrigation is largely dependent on artesian wells, this class of underground waters occupies a prominent place in the State laws.

Much of the legislation on this subject refers only indirectly to the underground water itself, being concerned with the duties of officials in regard to the sinking and controlling of wells, the appropriation of money, and the levying of taxes to provide for the cost of such wells, the rights and duties of those benefited by the water thus secured, and other topics of this general class. Material of this character has been omitted, brief references sometimes being given to the reports where it may be found.

Most of the States having special laws relating to underground waters are given below in alphabetical order, with such reference to their laws as seemed desirable for the purpose of this report.

CALIFORNIA.

The laws of California provide for the regulation of the use of artesian wells and prohibit the waste of subterranean waters. In an act (L., 1877–78, p. 195), approved in 1878, it is provided (sec. 1) that:

"Any artesian well which is not capped or furnished with such mechanical appliances as will readily and effectively arrest and prevent the flow of water from such well is hereby declared to be a public nuisance. The owner, tenant, or occupant of the land upon

which such well is situated who causes, permits, or suffers such public nuisance, or suffers or permits it to remain or continue, is guilty of a misdemeanor."

Also (sec. 2) that:

"Any person owning, possessing, or occupying any land upon which is situated an artesian well, who causes, suffers, or permits the water to unnecessarily flow from such well or to go to waste, is guilty of a misdemeanor."

For the purposes of this act an artesian well is defined (sec. 3) as "any artificial well the waters of which will flow continuously over the surface of the ground adjacent to such well at any season of the year;" and waste is defined (sec. 4) as follows: "The causing, suffering, or permitting the waters flowing from such well to run into any river, creek, or other natural water course or channel, or into any bay, lake, or pond, or into any street, road, highway, or upon the land of any person other than that of the owner of such well, or upon the public lands of the United States or of the State of California, unless it be used thereon for the purposes and in the manner that it may be lawfully used upon the land of the owner of such well: *Provided*. That this section shall not be so construed as to prevent the use of such waters for the proper irrigation of trees standing along or upon the street, road, or highway, or for ornamental ponds, or for the propagation of fish."

A fine of not less than $10 or more than $50, together with the cost of prosecution, is assessed against those convicted of violating any of the provisions of this act, and the supervisors or roadmasters are empowered to enter upon the premises where wells complained of are situated, and to institute criminal action where violation of the provisions of this act is discovered.

COLORADO.

The laws of Colorado regulate the use of artesian wells and prohibit the waste of subterranean waters in much the same way as the laws of California above cited. Further provisions are made for the keeping of accurate records of the depth and thickness of the different strata penetrated, for determining the legal status of seepage or spring waters, and for the sinking of certain artesian wells.

An act (L., 1887, p. 52) approved in 1887 provides (secs. 1 and 2) that: "Any artesian well which is not tightly cased, capped, or furnished with such mechanical appliances as will readily and effectively prevent the flow of water from such well is hereby declared to be a public nuisance. The owner, tenant, or occupant of the land upon which such well is situated, who causes, permits, or suffers such public nuisance, or suffers or permits it to remain or continue, is guilty of a misdemeanor.

"Any person owning, possessing, or occupying any land upon which is situated an artesian well, who causes, suffers, or permits the water to unnecessarily flow from such well, or to go to waste, is guilty of a misdemeanor."

For the purposes of this act an artesian well is defined much the same as under the California law above cited, except that it is provided that nothing in the act shall apply to water flowing from mining shafts, and the definition is made to read, "the waters of which, if properly cased, will flow continuously," etc.

Waste is defined as in the California law, with a few minor modifications in the wording, and with the provision that the use of the water for agricultural purposes is allowed in addition to the other uses enumerated above.

A fine of not less than $50 nor more than $300, together with the cost of prosecution, is assessed against anyone violating any of the provisions of the act. The county commissioners, road overseers, city engineer, or city officers are empowered to investigate and prosecute alleged violations of the act.

It is further provided (sec. 7) that: "Any person boring or causing to be bored an artesian well, shall keep a complete and accurate record of the depth and thickness of the different strata penetrated, and when such well is completed, shall file such record in the office of the county clerk and recorder of the county within which such well is situated, and immediately transmit a copy of such record to the office of the State engineer. Any person violating the provisions of this section shall be deemed guilty of a misdemeanor and shall, upon conviction, be fined not less than ten nor more than fifty dollars."

By an act (L., 1889, p. 215), approved in 1889, the rights relating to the use of seepage and spring waters are defined as follows: "All ditches now constructed or hereafter to be constructed for the purpose of utilizing the waste, seepage, or spring waters of the State shall be governed by the same laws relating to priority of right as those ditches constructed for the purpose of utilizing the water of running streams: *Provided*, That the person upon whose land the seepage or spring waters first arise shall have the prior right to such waters if capable of being used upon his lands."

A number of acts have been passed at different times providing for the sinking of artesian wells at certain localities and appropriating money therefor.

IDAHO.

The rights relating to subterranean waters in Idaho are thus defined (L., 1899, p. 380, secs. 2 and 23):

"The right to the use of the waters of rivers, streams, lakes, ponds, and subterranean waters may be acquired by appropriation.

"All ditches now constructed, or which may hereafter be constructed, for the purpose of utilizing seepage, waste, or spring water of the State shall be governed by the same laws relating to priority of right as those ditches, canals, and conduits constructed for the purpose of utilizing the waters of running streams."

MICHIGAN.

In the State of Michigan the question of well interference is dealt with as follows:

"No person or persons, or corporation other than municipal corporations, owning or operating any artesian well, shall allow the same to flow a larger stream than will flow through a pipe 1 inch in diameter, to the detriment or injury of any other well or wells, without the consent of the owners of such well or wells so injured.

"Any person or persons who shall suffer any damage because of the violations of the provisions of this act shall be entitled to recover the same from the person or persons or corporations so causing the same, the action of trespass or the case to be brought in any court of competent jurisdiction.

"This act shall not apply to salt, oil, mineral water, or gas wells, or wells leased for bath purposes." (L., 1889, p. 221.)

NEBRASKA.

In 1897 the following act was passed "to prohibit the needless waste of mutual artesian water in the State of Nebraska" (L., 1897, p. 358, chap. 84, secs. 1–3):

"That it shall be unlawful for the owner or owners, lessee or lessees, occupier or occupiers, foreman or superintendent of any farm, town lot, or other real estate in the State of Nebraska where artesian water has been found, or may be found hereafter, to allow the water from wells or other borings or drillings on any farm, town lot, or other real estate in Nebraska to flow out and run to waste in any manner to exceed what will flow or run through a pipe one-half of one inch in diameter, except where the water is first used for irrigation, or to create power for milling or other mechanical purposes.

"Any person or persons who own, occupy, or have control of any farm, town lot, or other real estate in the State of Nebraska who fail or refuse to shut off the wastage of artesian water to the amount that this act allows on any farm, town lot, or other real estate which they own, occupy, or have control of, after being notified in writing by any person having the benefit of said mutual water supply, within forty-eight hours after such notification, shall be subject to arrest and, upon conviction, be fined in any sum not less than ten nor more than twenty-five dollars, and pay the costs of such arrest and prosecution

or each offense; and if such wastage be not abated within twenty-our hours after such arrest and conviction, it shall be deemed a sec-nd offense against the provisions of this act and be subject to the ame fine as for the first offense, and each like offense or neglect of ach twenty-four hours thereafter shall be deemed and constitute an dditional offense against the provisions of this act.

"All prosecutions under the provisions of this act shall be brought y any person in the name of the State of Nebraska against any per-on or persons violating any of the provisions of this act, before any ustice of the peace of the county in which such violation is alleged to ave taken place, or before any court of competent jurisdiction."

NEVADA.

In order to encourage the search for artesian waters in the State of Nevada, several acts and amendments thereto have been passed providing bounties for those who sink artesian wells. Thus it is provided that the party sinking an artesian well, where flowing water in a specified quantity is obtained, shall receive the following bounties: For the first 200 feet, $1.25 per foot; for the third 100 feet, $1.50 per foot; for the fourth 100 feet, $2 per foot; and so on, up to $4.50 per foot for the tenth 100 feet; and for all depth exceeding 1,000 feet $5 per foot for each and every foot below the said 1,000 feet; together with an additional bounty of $1,000 for each well sunk to a depth of 1,000 feet or more. Certain conditions relating to the number of wells allowable within a given area, the amount of water required, and the persistence of flow, are prescribed.

Under certain prescribed conditions a bounty of $2,500 is offered to the person who first sinks a well in the State of Nevada, not less than 6 inches in diameter at the bottom, to a depth of 1,000 feet, said well flowing at least 60 gallons of water per minute.

A person engaged in the sinking of an artesian well upon any unoccupied public lands subject to selection by the State of Nevada, according to certain specified requirements, shall have a preferred right to all the lands he or she may be entitled to purchase under the provisions of certain acts providing for the selection and sale of the public lands of the State.

NEW JERSEY.

In 1904 an act (L., 1904, chap. 77, p. 188) was passed in New Jersey which empowered cities acquiring their water supply from artesian wells to improve and enlarge that supply, as follows:

"It shall and may be lawful for the governing board of any city now or hereafter acquiring its water supply from artesian wells, whenever in their judgment they shall deem it expedient to do so, to cause to be constructed an additional pipe line or main to connect

such water supply with any distributing reservoir within such city or with water-supply pipes or mains to any point within such city, and to dig and construct artesian wells, and to purchase and erect and to set up meters, machinery, and other fixtures in connection with and for the improvement of the water supply and waterworks plant of such city and to purchase and condemn land, waters, and rights, and otherwise to improve, enlarge, and extend said water supply and waterworks plant of such city, provided, however, that all such works shall be done and constructed by contract after public bidding therefor, in the manner prescribed in the laws now governing such city."

NEW MEXICO.

An act passed in 1897 authorizes any county in the Territory to issue and sell bonds for the purpose of sinking artesian wells. It states (L., 1897, chap. 66, sec. 2) that "the object of said wells shall be to ascertain whether flowing water can be procured on lands at present considered beyond and above the water belt—that is, above and beyond the belt wherein it has been demonstrated that flowing water can be obtained, and to encourage the boring of such wells for the purpose of increasing the area and productiveness of our agricultural lands and to reclaim high mesa lands which are now valueless for agricultural purposes."

By an act approved in 1903 the superintendent of the New Mexico penitentiary was authorized to provide for the drilling of an experimental well on land belonging to the penitentiary.

OKLAHOMA.

The laws of Oklahoma have definitely embodied the general principles upon which the common-law decisions relating to the different rights in underground and surface waters are based. Thus it is stated (Revised and Annotated Statutes, 1903, chap. 65, Property, art. 3): "The owner of the land owns water standing thereon or flowing over or under its surface, but not forming a definite stream. Water running in a definite stream formed by nature over or under the surface may be used by him so long as it remains there, but he may not prevent the natural flow of the stream or of the natural spring from which it commences."

OREGON.

The rights to seepage and spring waters in the State of Oregon are thus stated (L., 1893, p. 150): "All ditches now constructed, or hereafter to be constructed, for the purpose of utilizing the waste, spring, or seepage waters of the State shall be governed by the same laws relating to priority of right as those ditches constructed for the pur-

ose of utilizing the waters of running streams: *Provided*, That the erson upon whose lands the seepage or spring waters first arise shall ave the right to the use of such waters."

SOUTH DAKOTA.

A great deal of legislation has been enacted in South Dakota conerning artesian wells, especially acts providing for the sinking of uch wells, defining the rights and liabilities of those who do sink hem or who have control of them, and providing for the levying of axes and the issuing of bonds to pay the necessary expenses. Those ections referring to official duties, the levying of taxes, etc., are not ere considered, only the sections dealing more directly with subteranean waters being cited.

By a series of acts (L., 1889, chap. 14; 1890, chap. 103; 1891, chap. 80; 1893, chap. 109; 1895, chaps. 103, 106, 107, 108; 1897, chap. 74; 1903, chaps. 63, 64) and amendments thereto, it is provided that artesian wells may be sunk and watercourses be constructed therefrom upon petition of a majority of the qualified electors of any township in which the wells and the lands benefited thereby may be located; and that county, township, and special taxes may be levied to pay the cost of such wells and watercourses. Or any person or persons, corporation or company may construct artesian wells upon lands leased by them, and construct watercourses therefrom, the proprietors of such wells bearing the expense in proportion to their several interests. Certain restrictions are made regarding the number and location of waterways constructed from the wells, and the rights of parties controlling such waterways, of parties whose lands are crossed by them, and of the public are defined.

"All subterranean waters in the State of South Dakota may be used for irrigation, mechanical, and domestic purposes," according to the provisions stated in the several acts. One such provision requires the keeping of well records, as follows:

"It is hereby made the duty of the township board to embody in the contract for the sinking of said public artesian wells a proviso that the person sinking said wells shall make a record of the depth of each well and the formations entered or passed through in the construction of the same, and such provision is hereby made an essence of the contract and a violation thereof shall be construed to be a violation of the contract." (L., 1891, chap. 80, sec. 35.)

The danger of "well interference" is recognized, and certain provisions made for avoiding the trouble, so far as is practicable. Thus it is provided (L., 1891, chap. 80, sec. 42) that "Any person, association, or corporation owning land shall have the right to sink or bore an artesian well or wells on his, their, or its lands, for the purpose of procuring water for domestic use, for irrigation, or for manufactur-

ing purposes; but in wells hereafter constructed no more water shall be appropriated by such person, association, or corporation than is needed for said purposes, when such additional use of water interferes with the flow of wells on adjacent lands."

It has already been pointed out, in the first part of this report, that well interference may be foreseen and prevented to a greater or less extent by proper distribution of the wells. The decisions of the common law are in part based on the erroneous principle that it is impossible for any man to know until after his well is completed whether or not it will affect the flow of his neighbor's well. The State of South Dakota recognizes the possibility of foreseeing and preventing well interference, and deals with the question in the following manner:

"In locating wells in townships which have established and put down wells under the provisions of this act for public use or by private parties, due regard shall be had to their proper distribution, in order that the flow of the wells may be properly equalized and less likely to interfere with each other. Should any well in such township, public or private, be located so near any well already completed or in process of completion as to be likely to interfere with the same, any person may complain in writing to the State engineer, who shall without delay proceed to examine the locality and determine from its topography and the proximity of the wells whether, in his judgment, the wells as located would unduly interfere with the one already completed or in course of completion. If in his judgment there will be no material interference, the location will not be changed but if in his opinion the well as located will materially interfere with the one completed or in course of completion he shall change the location of said well to some more suitable locality; provided, that when permanent buildings have been located on any farm prior to the sinking of any artesian well on any adjoining farm, this act shall not be construed as prohibiting the agent or proprietor of said farm from sinking an artesian well at or near said building without reference to the proximity of any other artesian well. The State engineer shall within five days after said examination, make a written statement of his decision and file the same or a copy thereof in the office of the circuit court of the county wherein the said wells are located. Any person aggrieved by the decision of the State engineer may, within ten days after the filing of the decision in the office of the clerk of the circuit court, appeal from the same to the circuit court and upon such appeal the question shall be tried de novo." (L., 1891, chap. 84, sec. 43.)

In order to determine whether the amount of water flowing from an artesian well is increasing or decreasing, the State engineer

quired " to measure or to cause to be measured the flow and pressure f all artesian wells established and put down under the provisions f this act, public and private, at such times as he may deem proper, or the purpose of determining the increase or diminution of the flow r pressure of said well, and is hereby authorized to enter upon any rounds for the purposes aforesaid, and the owner or owners of such vell or wells are hereby directed to furnish the necessary material to onstruct a suitable weir to measure the flow, and all reasonable conveniences shall be afforded for this purpose." (L., 1891, chap 80, ec. 44.)

Every person sinking an artesian well is required to provide for such well a proper casing, in order to prevent the well from caving in and to prevent the escape of the water when it is desirable that such water be confined; and he is further required to provide such valve and appliances as will enable him to control the flow of the water from the well. Concerning the wasting of artesian waters, it is provided (L., 1891, chap. 80, sec. 46) that: " No person controlling an artesian well shall suffer or permit the water therefrom to flow to waste unless and so far as reasonably necessary to prevent obstruction thereof, or o flow or to be taken therefrom save for beneficial uses: *Provided*, This shall not be so construed as to prevent the reasonable use of said water for the necessary irrigation of trees standing along or upon any street, road, or highway, or for ornamental ponds or fountains, or the propagation of fish."

If any person complains that the proprietor of an artesian well, or he party controlling such well, is in the habit of letting the waters go o waste, the township supervisor, county commissioner, road overseer, lderman, or other city officers may enter upon the premises where the well is located in order to determine whether the complaint is justified, and may institute criminal prosecution in case violation of the law is ascertained. If the well is without valves to regulate the flow and prevent waste, the person owning the well may be fined up to one hundred dollars or be imprisoned not more than three months in jail, or both.

The flow of water through a watercourse from any artesian well is not to be interfered with, it being the duty of every person through whose land such a watercourse runs to keep the same open and unobtructed. The road overseer must keep such watercourses along a public highway clear. It is further provided (L., 1893, chap. 109, ec. 32) that: "All natural watercourses in this State, whenever an artesian well is located thereon under the provisions of this act, are hereby created and declared public natural watercourses for the flow of water from such artesian wells for the benefit of the public and of

private individuals located on such watercourses, subject only to compensation for damages as in this act provided."

UTAH.

"The waters of all streams and other sources in this State, whether flowing above or underground in known or definite channels, are hereby declared to be the property of the public, subject to all existing rights to the use thereof." (L., 1903, chap. 100, sec. 47.)

WASHINGTON.

In the State of Washington the rights to seepage and spring waters are thus defined:

"All ditches now constructed or hereafter to be constructed for the purpose of utilizing the waste, seepage, or spring waters of the State shall be covered by the same laws as those ditches constructed for the purpose of utilizing the water of natural streams and lakes: *Provided*, That the person upon whose land the seepage or spring waters first rise shall have a prior right to such waters, if capable of being used upon his lands." (L., 1890, p. 710, sec. 15.)

In 1901 an act was passed "in relation to artesian wells and regulating the flow of waters therefrom; and providing a penalty for the violation thereof." (L., 1901, p. 259, sec. 1–4.) The text of this act is given in full:

"It shall be unlawful for any person, firm, corporation, or company having possession or control of any artesian well within the State, whether as contractor, owner, lessee, agent, or manager, to allow or permit water to flow or escape from such well between the first day of October in any year and the first day of April next ensuing: *Provided*, That this act shall only apply to sections and communities wherein the use of water for the purposes of irrigation is necessary or customary: *And provided further*, That nothing herein contained shall prevent or prohibit the use of water from such well between the first day of October and the first day of April next ensuing for household, stock, and domestic purposes only, water for the last-named purposes to be taken from such well through a one-half inch stop and waste cock to be inserted in the piping of such well for that purpose.

"It shall be the duty of every person, firm, corporation, or company having possession or control of any artesian well as provided in section 1 of this act to securely cap the same over, on or before the first day of October in each and every year, in such manner as to prevent the flow or escape of water therefrom, and to keep the same securely capped and prevent the flow or escape of water therefrom until the first day of April next ensuing: *Provided, however*, It shall and may be lawful for any such person, firm, corporation, or company to insert

one-half inch stop and waste cock in the piping of such well and to ake and use water therefrom through such stop and waste cock at ny time, for household, stock, and domestic purposes, but not otherise.

"Any person, whether the owner, lessee, agent or manager, having ossession of any such well, violating the provisions of this act shall e deemed guilty of a misdemeanor, and upon conviction thereof shall e fined in any sum not exceeding two hundred dollars for each and very such offense, and the further sum of two hundred dollars for ach ten days during which such violation shall continue.

"Whenever any person, firm, corporation, or company in possesion or control of an artesian well shall fail to comply with the proisions of this act, any person, firm, corporation, or company lawfully n possession of the land adjacent to or in the vicinity or neighborood of such well, and within five miles thereof, may enter upon the and upon which such well is situated and take possession of such, from which water is allowed to flow or escape in violation of the provisions of section 1 of this act, and cap such well and shut in and secure the flow or escape of water therefrom, and the necessary expense incurred in so doing shall constitute a lien upon said well, and a sufficient quantity of land surrounding the same, for the use and operation thereof, which lien may be foreclosed in a civil action in any court of common jurisdiction, and the court in any such case shall allow the plaintiff a reasonable attorney's fee, to be taxed as a part of the cost. This shall be in addition to the penalty provided for in section 3 of this act."

WISCONSIN.

In the State of Wisconsin the questions of well interference and the wasting of artesian waters are thus dealt with:

"Where there are two or more artesian wells in any vicinity or neighborhood, one or more of which are operated or used by any person or owner, the person or owner of such well shall use due care and diligence to prevent any loss or waste or unreasonable use of the water therein contained or flowing from the same, as would deprive or unnecessarily diminish the flow of water in any artesian well, to the injury of the owner of any other well in the same vicinity or neighborhood.

"Any person who shall needlessly allow or permit any artesian well owned or operated by him to discharge greater quantities of water than is reasonably necessary for the use of such person, so as to materially diminish the flow of artesian water in any other well in the

same vicinity, shall be liable for all damages which the owner of any such other well shall sustain." (L., 1901, chap. 354.)

WYOMING.

According to the provisions of an act (L., 1888, chap. 19) passed in 1888, the boards of county commissioners of the several counties in the State of Wyoming are authorized to provide for the sinking of artesian wells at various places within such counties; and where the nature of the country makes an artesian well impracticable, tanks, reservoirs, etc., may be constructed. Certain restrictions are imposed, the rights and duties of private citizens and officials are defined, and appropriation of money is authorized.

INDEX.

A. Page.

Abbreviations, use of ---------- 7–8
Acme Oil Co., Dillon *v.* *See* Dillon *v.* Acme Oil Co.
Acton *v.* Blundell, decision in, on percolating waters --- 13–14
decision in, on well interference ---------- 15
Agreements, effect of ---------- 30–31, 34
strict construction of --------- 31
Alexander *v.* United States, decision in, on well interference ---------- 17
Alston *v.* Grant, decision in, on pollution ---------- 26
American and English Encyclopedia of Law: Underground Waters, citations from- 7
Angell, J. K., on nature of property in percolating water-- 36
Appropriation, prior, establishment of ---------- 12
laws concerning----- 41–42, 44–45, 48
Arid and humid States, different rules in ------ 20–21, 32–33

B.

Ball *v.* Nye, decision in, on pollution ---------- 26
Ballacorkish Mining Co. *v.* Harrison, decision in, on agreements ---------- 30
v. Dumball, decision in, on well interference -------- 15
Ballard *v.* Tomlinson, decision in, on pollution ---------- 25, 26
Barrows, J., decision of, on motives- 30
Bartlett, J., decision of, on well interference ---------- 16
Barnard *v.* Shirley, decision in, on disposal of intercepted water ---------- 22
decision in, on pollution------- 27–28
Bassett *v.* Salisbury Mfg. Co., decision in, on well interference ---------- 16
decision in, on damming underground water-------- 21
Baugh, Wheatley *v.* *See* Wheatley *v.* Baugh.
Bellows, C. J., decision of, on motive ---------- 30
Bennett, E. H., on pollution-------- 25

Page.

Benton, Harwood *v.* *See* Harwood *v.* Benton.
Black, J., decision of, on motives--- 29
Blundell, Acton *v.* *See* Acton *v.* Blundell.
Boston and Maine R. R., Parker *v.* *See* Parker *v.* Boston and Maine R. R.
Braintree Water Supply Co., proprietors of Mills *v.* *See* Proprietors of Mills *v.* Braintree Water Supply Co.
Brett, M. R., decision of, on pollution ---------- 26
Brinkerhoff, J., on public policy and rights in percolating water ---------- 14
on motive---------- 29
on prescription---------- 32
Brookline, Trowbridge *v.*, decision in, on well interference -- 16–17
Brooklyn, Smith *v.* *See* Smith *v.* Brooklyn.
Brown, Strait *v.* *See* Strait *v.* Brown.
Brown *v.* Illius, decision in, on pollution---------- 27
Brown, Frazier *v.* *See* Frazier *v.* Brown.

C.

California, common-law decisions in- 16, 18, 19, 20–21, 32–33, 38, 39
statute laws of---------- 39–40
Case *v.* Hoffman, decision in, on existence of underground streams ---------- 10
Cemeteries, damage from---------- 26
Channels, underground, defined and known, definition of -- 10
See also Streams, underground.
Chasemore *v.* Richards, decision in, on stream-supply interference ---------- 19
Chartiers V. Gas Co., Collins *v.* *See* Collins *v.* Chartiers V. Gas Co.
Chauvet *v.* Hill, decision in, on spring interference --- 18
Chesley *v.* King, decision in, on motives ---------- 30
Church, Womersley *v.* *See* Church *v.* Womersley.

Page.

Clark v. Lawrence, decision in, on pollution ---------- 26
Collins, Pickard v. *See* Pickard v. Collins.
Collins v. Chartiers V. Gas Co., decision in, on precedents ---------- 35
Colorado, statute laws of---------- 40–41
Coloring matter, underground transmission of, proofs by-- 11
Connecticut, common-law cases in -- 27
Cooley, J., decision of, on pollution- 27
Corporations, status of, in regard to percolating water- 16–18, 32
Cronin, Walker v. *See* Walker v. Cronin.
Crops, injury to, by abstraction of percolating water---- 19–21
Cutts, Swett v. *See* Swett v. Cutts- 30

D.

Damming streams, right of-------- 12
Damming underground water, damages from ---------- 21, 33
Dickinson v. Grand Junction Canal Co., decision in, on stream-supply interference ---------- 19
Dillon v. Acme Oil Co., decision in, on pollution --------- 27
Ditches. *See* Sewers.
Draining land, damages to water supply from ---------- 17–18
Dufour, Southern Pacific R. R. Co. v. *See* Southern Pacific R. R. Co. v. Dufour.
Dumball, Ballacorkish Mining Co. v. *See* Ballacorkish Mining Co. v. Dumball.
Durham, Porter v., on motives----- 29

E.

Elster v. Springfield, decision in, on spring interference--- 18
Excavating, damages to water supply from------ 16–18, 27, 32

F.

Fall River Iron Works Co., Sherman v. *See* Sherman v. Fall River Iron Works Co.
Farmer, Stillwater Water Co. v. *See* Stillwater Water Co. v. Farmer.
Fletcher, Rylands v. *See* Rylands v. Fletcher.
Forbell v. New York, decision in, on injury to land ------- 20
Fowler, Jenkins v. *See* Jenkins v. Fowler.

Pa

Frazier v. Brown, decision in, on public policy and rights in percolating water--
decision in, on motives-------
on prescription----------

G.

Gas refuse, pollution by---------- 25
Gould, J. M., Law of Waters by, citations from----------
definition by----------
on agreements ---------- 30
on artificial percolation -------
on damming underground waters ----------
on disposal of intercepted waters ---------- 22
Grand Junction Canal Co., Dickenson v. *See* Dickinson v. Grand Junction Canal Co.
Grand Junction Canal Co. v. Shugar, decision in, on artificial percolation ------
Grant, Alston v. *See* Alston v. Grant.
Grants. *See* Agreements.
Gray, John C., acknowledgments to-
Greencastle v. Hazelett, decision in, on pollution ---------
Ground, imperfect support of, damage to water supply from ----------
Gumbert v. Kilgore, decision in, on spring interference ---

H.

Harrison, Ballacorkish Mining Co. v. *See* Ballacorkish Mining Co. v. Harrison.
Hart v. Jamaica Pond Aqueduct Co., decision in, on well interference ---------
Harwood v. Benton, decision in, on damming underground water ----------
Hathesly, Lord, L. C., decision of, on artificial percolation--
Hazelett, Greenfield v. *See* Greenfield v. Hazelett.
Hill, Chauvet v. *See* Chauvet v. Hill.
Hoffman, Case v. *See* Case v. Hoffman.
Hougan v. Milwaukee and St. Paul R. R. Co., decision in, on well interference --

I.

Idaho, statute laws of ---------- 41
Illinois, common-law cases in ------
Illius, Brown v. *See* Brown v. Illius.
Indiana, common-law cases in------ 2

Page.
Injunctions, granting of 26
Iowa, common-law decision in 16, 17

J.

Jacobs, Wheelock v. *See* Wheelock v. Jacobs.
Jamaica Pond Aqueduct Co., Hart v. *See* Jamaica Pond Aqueduct Co. v. Hart.
Jenkins v. Fowler, decision in, on motive 29
Johnson, New River Co. v. *See* New River Co. v. Johnson.
Johnstown Cheese Mfg. Co. v. Veghte, decision in, on agreements 31

K.

Katz v. Walkinshaw, decision in, on well interference 16, 20–21, 32–33, 38, 39
Kentucky, common-law cases in 25
Kenyon, West Cumberland Iron Co. v. *See* West Cumberland Iron Co. v. Kenyon.
Kilgore, Gumbert v. *See* Gumbert v. Kilgore 18
King, Chesley v. *See* Chesley v. King.
Kinnaird v. Standard Oil Co., decision in, on pollution 25

L.

Land, damages to, from interference with percolating water 19–21, 33
Land, drainage of, damages to water supply by 30
Law, common, on underground waters 9–38
Law, statute, on underground waters 39–49
Lawrence, Clark v. *See* Clark v. Lawrence.
Lawyer's Reports Annotated, citations from 7
Lewis, C. J., decision of, on indefinite character of percolating water 14
decision of, on motives 29
on spring interference 18

M.

Martinsville, Skaggs v. *See* Skaggs v. Martinsville.
Massachusetts, common-law decisions in 12, 16, 17, 23, 26, 29
Metropolitan Board of Works, Regina v. *See* Regina v. Metropolitan Board of Works.
Michigan, statute laws of 42

Page.
Milwaukee and St. Paul R. R. Co., Hougan v. *See* Hougan v. Milwaukee and St. Paul R. R. Co.
Mines, damages to water supply from 15, 23
flooding adjacent mines by water from 21, 22–24
Mirfield, Turner v. *See* Turner v. Mirfield.
Mitchell, J., on progress of geological knowledge 35
Motive, immateriality of 24, 28–29, 33
materiality of 27, 30, 33

N.

Nebraska, statute laws of 42–43
Negligence, effect of 24, 27, 28
Nevada, bounties for artesian wells in 43
common-law decisions in 19
statute laws of 43
New Albany and Salem R. R. Co. v. Peterson, decision in, on well interference 17
New Hampshire, common-law decisions in 15–16, 21, 22
New Jersey, statute laws of 43–44
New Mexico, statute laws in 44
New River Co. v. Johnson, decision in, on well interference 15
New York, common-law cases in 20, 27, 29, 31
New York, Forbell v. *See* Forbell v. New York.
Nowlen, Phelps v. *See* Phelps v. Nowlen.
Nye, Ball v. *See* Ball v. Nye.

O.

Ohio, common-law decisions in 17, 18, 29
Oil, pollution by 25
Oklahoma, statute laws of 44
Oregon, statute laws of 44–45

P.

Parker v. Boston and Maine R. R., decision in, on well interference 16
Pennsylvania, common-law decision in 14, 23, 29, 35
Percolating water, court precedents concerning 34–35
damming of, damage from 21, 33
distinction between other real estate and 36–38
distinction between surface streams and 11–13, 32
existence of, presumption in favor of 9, 10
interference with, damages from 13–31
knowledge of 9, 34–38

Page.

Percolating water, lack of agreement concerning ---------- 34, 38
legal rights in ---------- 12–31
ownership in ---------- 13, 32, 36
pollution of ---------- 25–28, 33, 36
priority of use of---- 41–42, 44–45, 48
public policy and rights in----- 14
sale of, right of-- 16, 20–21, 32–33, 37
waste of ---------- 18
Percolating waters, intercepted, disposal of---------- 21–22, 33
Percolation, artificial production of ---------- 22–24, 33
Perry, Willis *v.* *See* Willis *v.* Perry.
Peterson, New Albany and Salem R. R. Co. *v.* *See* New Albany and Salem R. R. Co. *v.* Peterson.
Phelps *v.* Nowlen, decision in, on motive ---------- 29
Pickard *v.* Collins, decision in, on motive ---------- 29
Pollution of underground water, liability for --------- 25–28
Pollution, motive of---------- 27, 28, 33
Pomeroy, J. N., Water Rights by, citations from ------- 7
Porter *v.* Durham, decision in, on motive ---------- 29
Prescription, nonapplicability of- 31–32, 34
Privies, damage from---------- 26–27
Proprietors of Mills *v.* Braintree Water Supply Co., decision in, on artificial percolation --------- 23
Public policy, rights in percolating water and---------- 14

R.

Reasonable use of percolating waters, decisions concerning -- 15–16, 20, 22, 28, 32, 33
Regina *v.* Metropolitan Board of Works, decision in, on interference with springs ---------- 17
Reinbach, Wahle *v.* *See* Wahle *v.* Reinbach.
Reservoir, percolation from, damages by ---------- 23–24
Richards, Chasemore *v.* *See* Chasemore *v.* Richards.
Richland Township Co., Upjohn *v.* *See* Upjohn *v.* Richland Township Co.
Rocks, structural relations of, proofs of underground channels from---------- 10
Rodman, J., decision in, on motive-- 29
Rylands *v.* Fletcher, decision in, on artificial percolation -- 24
decision in, on pollution of underground water ----- 25

S.

Salisbury Mfg. Co., Bassett *v.* *See* Bassett *v.* Salisbury Mfg. Co.
Sewage, pollution by---------- 25,
Sewers, construction of, damage to water supply by--- 16–19,
Sherman *v.* Fall River Iron Works Co., decision in, on pollution ----------
Shirley, Barnard *v.* *See* Barnard *v.* Shirley.
Shugar, Grand Junction Canal Co. *v.* *See* Grand Junction Canal Co. *v.* Shugar--
Sink holes, proof of underground channel furnished by-
Skaggs *v.* Martinsville, decision in, on disposal of intercepted waters--------
Smith *v.* Brooklyn, decision in, on stream-supply interference ----------
Solid matter, underground transmission of, proofs furnished by ----------
Southern Pacific R. R. Co. *v.* Dufour, decision in, on spring interference --- 17-
Springfield, Elster *v.* *See* Elster *v.* Springfield ----------
Springs, grant of, implications of--- 18,
interference with---------- 17-
streams from, riparian rights on ---------- 18,
Standard Oil Co., Kinnaird *v.* *See* Kinnaird *v.* Standard Oil Co.
Stillwater Water Co. *v.* Farmer, decision in, on spring interference ----------
Strait *v.* Brown, decision in, on stream-supply interference ----------
Streams, surface, distinction between percolating waters and ---------- 11–13
legal identity of underground streams and------ 11, 27
legal rights in and limitations on ---------- 11–12,
percolating water supply for, interference with ---- 18-
22-23
Streams, underground, distinction between percolating waters and-------- 11–13
legal identity of surface streams and ---------- 11
presumption against existence of 9
proofs of existence of--------- 10
Strong, T. R., decision of, on motive ----------
Swett *v.* Cutts, decision in, on motive ----------

T. Page.

J., on nature of property in percolating water ---- 37
'. J., on indefinite character of percolating water-- 13–14
n, Ballard v. *See* Ballard v. Tomlinson.
sion, underground, proofs of channel furnished by ---------- 10
ge, v. Brookline, decision in, on well interference -- 16–17
v. Mirfield, decision in, on pollution ---------- 26

U.

ound water. *See* Water, underground.
tates, Alexander v., decision in, on well interference ---------- 17
v. Richland Township Co., decision in, on pollution ---------- 27
tute laws of ---------- 48

V.

ercolating water from, damage by---------- 26
Johnstown Cheese Mfg. Co. v. *See* Johnstown Cheese Mfg. Co. v. Veghte.
, common-law decisions in-- 18, 21

W.

, Wilson v. *See* Wilson v. Waddell.
). Reinbach, decision in, on pollution ---------- 27

Page.

Walker v. Cronin, decision in, on motive ---------- 29
Walker, George A., acknowledgments to ---------- 7
Walkinshaw, Katz v. *See* Katz v. Walkinshaw -------- 16
Washington, statute laws of------- 48–49
Water, underground, classes and definition of --------- 9–10
See also Streams, underground; Percolating waters.
Wells, construction of, damages to other water supply from- 14–17, 19, 22–23, 30–33
interference with- 14–17, 32, 45–46, 49
Wells, artesian, bounties for drilling of ---------- 43
control of---------- 40
definition of ---------- 40, 41
flow from ---------- 46–47
records of---------- 40, 41, 45
streams from, riparian rights on---------- 47–48
statute laws on ---------- 39–50
water from, waste of---- 39–43, 47–49
disposal of ---------- 22, 27–28
pollution of ---------- 27–28
Wells, J., decision of, on motive---- 29
West Cumberland Iron Co. v. Kenyon, decision in, on intercepted water ---- 22
Wheatley v. Baugh, decision in, on spring interference --- 18
on motive ---------- 29
Wheelock v. Jacobs, decision in, on spring interference --- 18
Willis v. Perry, decision in, on well interference -------- 16
Wilson v. Waddell, decision in, on artificial percolation-- 24
Wisconsin, statute laws of--------- 49–50
Womersley v. Church, decision in, on pollution--------- 26
Wyoming, statute laws of --------- 50

O

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 122.]

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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGY AND UNDERGROUND WATER CONDITIONS

OF THE

JORNADA DEL MUERTO, NEW MEXICO

BY

CHARLES ROLLIN KEYES

WASHINGTON

GOVERNMENT PRINTING OFFICE

1905

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South Dakota, by N. H. Darton, in Eighteenth Annual, Pt. IV; Rock waters of Ohio
Orton, in Nineteenth Annual, Pt. IV; Artesian well prospects in the Atlantic Coastal Pla
N. H. Darton, Bulletin No. 138.

Correspondence should be addressed to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SUR
WASHINGTO

APRIL, 1905.

Water-Supply and Irrigation Paper No. 123 Series { B, Descriptive Geology, 66
O, Underground Waters, 36

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
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1905

ILLUSTRATIONS.

		Page.
ATE I.	Geologic sketch map of the Jornada	10
II.	Cross section of the region, along the lines A-A, B-B, and C-C, Pl. I.	12
III.	*A*, View of northern end of the Jornada; *B*, Peña Blanca, the white cliffs at lower end of Organ Mountains	14
IV.	*A*, Escarpment of the Chupadera Mesa; *B*, Peñasco Rock	16
V.	*A*, Elephant Butte, view taken from big bend in Rio Grande; *B*, Soledad Canyon, a mountain arroyo	18
VI.	*A*, Organ Mountains, New Mexico, showing break off or change in topography; *B*, View showing location of canal line running along small ridges directly back of Agricultural College	20
VII.	*A*, International reservoir site, 2½ miles above international dam site; *B*, River bed at international reservoir site, view taken from big bend in river	22
VIII.	Topography of the Fort Selden eruptive area	24
IX.	*A*, Organ Mountains, New Mexico, showing a portion of the mountains; *B*, Natural dike near Elephant Butte	26
FIG. 1.	Location of the Jornada del Muerto	9
2.	Geologic column	18
3.	Mescal cone, resting on Cretaceous sandstones	25
4.	Basin Range structure of the Jornada	26
5.	Small reversed fault in western rim of Jornada	29
6.	Caballos Peak and thrust plane	29
7.	Normal faulting at Napoleon mine	30
8.	Normal faulting at El Capitan mine	30
9.	Basic dike in Cretaceous sandstone	31
10.	Basic dike disturbing level sandstones	31
11.	Acidic dike in Carboniferous limestones	32

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., July 15, 1904.

SIR: I transmit herewith a report by Prof. Charles R. Keyes on the geology and underground water resources of the Jornada del Muerto, in south-central New Mexico, and recommend that it be published in the series of Water-Supply and Irrigation Papers.

The work resulting in this report was done under the supervision of Mr. N. H. Darton, chief of the western section of the division of hydrology. It presents new and valuable information regarding the geologic structure of this large desert area and shows that the conditions are favorable for the extensive occurrence of underground waters which, to some extent, are available for irrigation and domestic supplies. The region is one of fine climate and fertile soil, and the development of its underground waters will afford the means for sustaining settlers at a number of localities.

Very respectfully,

F. H. NEWELL,
Chief Engineer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

·EOLOGY AND UNDERGROUND WATER CONDITIONS OF THE JORNADA DEL MUERTO, NEW MEXICO.

By Charles Rollin Keyes.

INTRODUCTION.

Of the basin plains of southwestern United States the Jornada del [uerto, in south-central New Mexico, is, in many ways, one of the most

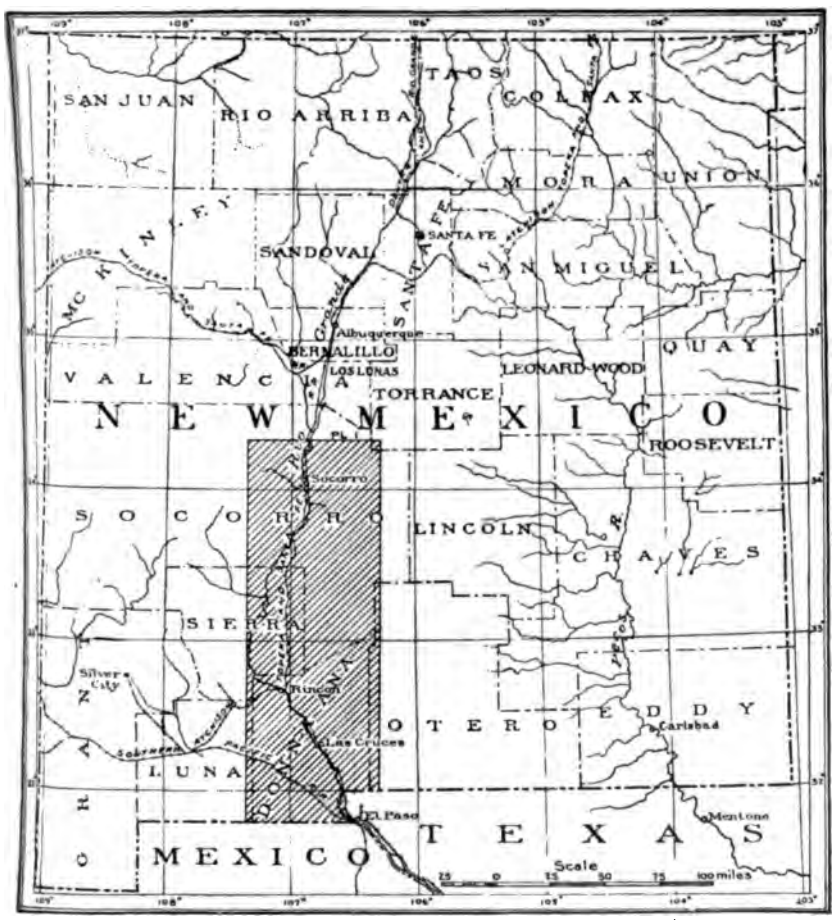


Fig. 1.—Location of the Jornada del Muerto.

·emarkable. This plain is typical of a very large number of dry ·ndy plains which characterize the arid region and which show but

few signs of surface waters. As it is covered by loose, porous soils unknown depth all the rainfall is quickly absorbed and the strea entering the plain from the mountains around the periphery soon si below the surface.

In the long period that preceded the coming of the European adjoining country was thickly populated by races highly skilled agriculture and well trained in the art of irrigation, yet no one of native peoples was tempted to settle upon this great strip of des For three hundred and fifty years after the Spanish invasion the J nada lay in the beaten path of travel from Mexico northward. 100 miles the famous El Paso and Santa Fe trail crossed its de sands. In view of the horrors inspired by the trip across it from time of Coronado to the advent of the railroad, the Spaniards ventured within its borders might well be pardoned for calling it "Journey of Death." The long white line of bleached bones of and horse, which not so very long ago marked the trail, amply atte the fitness of the title.

Wallace[a] has described the Jornada in very somber though hig fanciful terms as follows:

> Near the southern boundary of New Mexico the Spanish explorers were opp by a barrier of all on earth most to be dreaded—a shadeless, waterless pla nearly 100 miles long, from 5 to 30 miles wide, resembling the steppes of nort Asia. * * *
>
> The portion I speak of appears to have served its time, worn out, been dispeo and forgotten. The grass is low and mossy, with a perishing look—the shrubs, s weed, and bony cactus writhing like some grisly skeleton; the very stones are the scoria of a furnace. You vainly look for the flight of a bird, such as cheere eyes of Thalaba in the desert; no bee nor fly hums in the empty air; and, sav lizard (the genius of desolation) and horn frog, there is no breath of living thin
>
> Standing on the edge of the measureless waste, which is trackless as water first explorers might ask, "What is this strange ocean of sand, with its stillness awful than any sea?"
>
> The spot I am trying to describe is the battle ground of the elements. In w it is made fearful by raging storms of wind and snow. There men and animals been frozen to death, their bodies left the lawful prey of the mountain wolf. the primeval years the Apache has harried the hungry waste, hunting for s and, besides the savagest of savages, it is now the favorite skulking place of out an asylum for fugitives escaping justice in old Mexico and Texas.
>
> In our times many a party cut off and many a traveler murdered makes goo name it bears, given by the first white men who dared its perils, Jornada del Mue "Journey of Death."

Repulsive as this picture is, it scarcely exaggerates the widesp impression which formerly existed concerning this country. much of the arid region, this district was considered waterless bec no water appears on the surface. For three hundred and fifty y the traveler traversed this region without taking the trouble to beneath the surface of the plain for the moisture he so often longed

[a] Wallace, S. E., Land of the Pueblos, New York, 1888, p. 140.

Apparently it was not suspected that, owing to certain local peculiarities in the geologic formations, abundant water lay at comparatively shallow depths. In 1871 a well 160 feet deep was dug in the middle of the plain by a ranchero, John Martin, and cool, soft water was obtained in great quantity, so that his ranch became the resting place of every traveler crossing the desert.

The geologic conditions in New Mexico are less known than in any other region of equal size in the United States. With the exception of a few comparatively limited areas studied by the Federal surveys, but little detailed investigation has been undertaken. The geologists connected with the early Government surveys have given a general idea of the geologic formations, but the exact age and relations of most of the rocks remain to be determined.

GENERAL CHARACTER OF THE NEW MEXICAN PLATEAU REGION.

Among the most notable features of central and southwestern New Mexico are the broad desert plains, out of which the mountain ridges rise as abruptly as volcanic islands out of the sea. These plains are 20 to 30 miles wide, often 100 miles or more long, and at first glance appear nearly level. Closer inspection shows that they are basins inclined toward the center and devoid of marked drainage ways or drainage outlets.

With their usual keen distinctions of geographic features, the Spanish aptly call such an inclosed plain a "bolsone," meaning a purse. Of these plains a writer, who has brought their Spanish name into geographic usage, says:

> These plains or "basins," as they are sometimes called, are largely structural in origin. Bolsons are generally floored with loose unconsolidated sediments derived from the higher peripheral region. Along the margin of these plains are talus hills and fans of bowlders, and other wash deposits brought down by mountain freshets. The sediments of some of the bolsons may be of lacustral origin.
>
> It is essential in both the geographic and the geologic discussion to bear in mind the distinction between bolson plains and plateau plains. The plateau plains and the mountains are genetically related, the strata composing the one being bent on to or flexing out into the other. The bolson plains, on the other hand, are newer and later topographic features consisting of structural valleys between mountains or plateau plains, which have been partially filled with débris derived from the adjacent eminences. The plateau plains are usually destructional stratum plains. The bolson plains are constructional detritus plains filling old structural troughs. [a]

The distinction between the plateau plains and the bolson plains is as important as it is real. But the statement that bolson plains are constructional detritus plains in structural valleys does not convey a correct idea of the phenomenon, and, as generally understood, the term structural, as applied to these valleys, is very apt to be misinterpreted.

[a] Hill, R. T., Topographic Atlas U. S., folio 3, U. S. Geol. Survey, 1900, p. 8.

In a carefully qualified sense the valleys occupied by the bolson might, perhaps, be considered structural valleys, but their histc very much more complex and very different from what might be pected from casual observation.

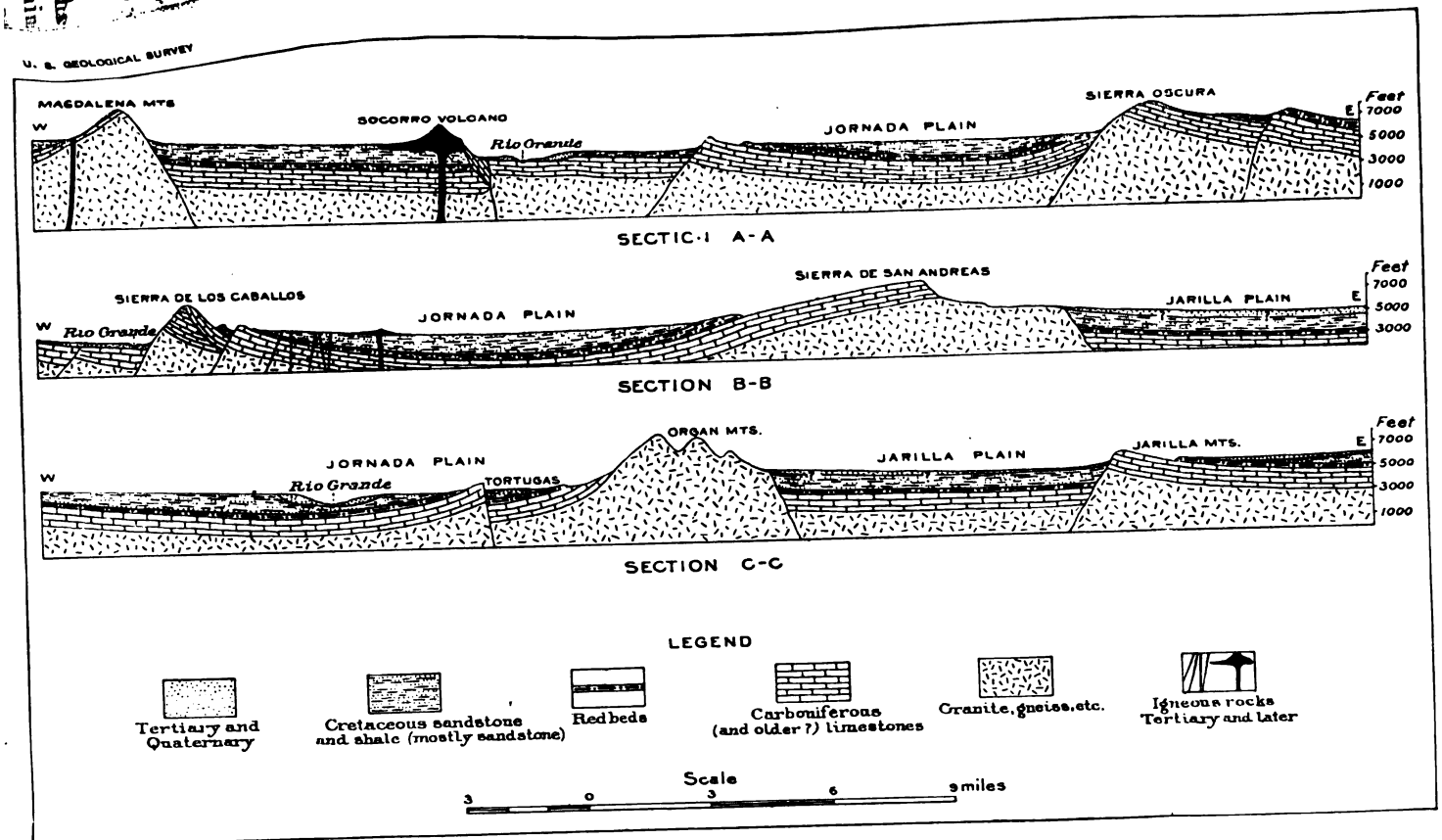
The alternation in central New Mexico of narrow mountain r and broad plains, of which the Jornada is a characteristic exa presents some features which are not easily understood unti regions both to the east and to the west are taken into consider In both directions the basin character of the bolson plains is soon The plains become confluent and more continuous, and the mou ranges more disconnected and finally isolated altogether. Farth the plain alone persists without notable mountains. This conc continues on the one hand to the Gulf of California and on the to the Gulf of Mexico.

At the beginning of Tertiary time the region between the two gulfs south of what is now the Colorado line must have been a lowland plain with but faint relief features. A large part of this was on the beveled edges of Cretaceous and older strata, as is sl now in its remnants still clearly discernible. The Las Vegas Pla the Llano Estacado, the bolson plains of central New Mexico, some of the less broken plains of eastern Arizona seem to be genetically together. To the east and the west a broad subm platform was formed from the sediments derived from the planir of the central land area. When the general uplift of the region place later in the Tertiary the great plain formed was partly a plain of destructional land origin and partly a constructional pla marine origin.

In the uprising, however, faulting took place on a large scale, ing rise to the numerous monoclinal block mountains in the re now within the boundaries of New Mexico. There were various in the general uplift, and the Mesozoic and youngest Paleozoic were stripped off the mountain summits. Two or three times du halts in the uplift partial planation took place. With the pro sion of the uplift the mountain blocks finally became more and tilted.

Between Tertiary and present time an enormous amount of sion has taken place. The vast plain has been deeply dissected b Canadian, Pecos, Rio Grande, and Colorado rivers—old, mountain streams. The valleys of these water courses are very wide and On the east the Canadian flows 4,000 feet below the level of th plain, the Pecos perhaps 2,500 feet, the Rio Grande about 1,500 while the Colorado Canyon is a mile deep.

In the Llano Estacado the remnant of the great high plain h area of 50,000 square miles. The bolsons are already beginni give way to erosion agencies. In the valley of the Rio Grande n



CROSS SECTION OF THE REGION, ALONG LINES A-A, B-B, AND C-C, PL. I.

l traces of one old plain are already destroyed. The displaced inter-ontane basins like the Jornada, which adjoin the long Rio Grande alley, are being deeply dissected wherever the great river touches e borders.

SURFACE RELIEF OF THE JORNADA.

GENERAL FEATURES.

The Jornada basin is roughly pear-shaped in outline, with the stem d at El Paso (see geologic sketch map, Pl. I). From this point the sin plain extends northward into central New Mexico, a distance 200 miles. In width the plain expands to 30 or 40 miles.

Of late years only the central part of the basin has been called the rnada del Muerto. As a physiographic feature the plain is broken from the Mesa Jumanes and the Cerro Montosa, which cuts off to the north from the great Estancia bolson, to the canyon of e Rio Grande at El Paso. The Mesilla Valley is not a separate sin, as often reported, but a portion traversed by the Rio Grande, hich enters the lower part of the plain.

In the central part the Jornada is a flat-bottomed basin, with borders rned abruptly upward on all sides like a miner's pan. Forming the im are long, narrow mountain ranges which rise to heights of 2,000 3,000 feet above the plain. The floor of the basin slopes to the uth. At the north end the altitude is about 6,300 feet, while at the uthern extremity it is 3,800 feet. There is a descent of 2,500 feet 200 miles, a rate of about 12 feet to the mile.

West of the Jornada, running its entire length, is the Rio Grande el Norte, which flows in a basin of its own. While at the north end he elevation of the Jornada is 1,600 feet above the river, at the south-rn limit where the stream cuts across the rim the height above the reat water course is only about 100 feet. The river falls 1,000 feet a distance of 200 miles; the fall of the plain in the same distance is ,500 feet or more.

Viewed from the railroad the plain appears even and level, the nly features breaking the smoothness of its general surface being olated and irregular volcanic cones which follow down the middle of he basin for its entire length. These, however, are recent outflows n the surface of the plain and genetically do not interrupt its continuity.

Where the Rio Grande touches the Jornada, and where it traverses s southern part, the plain is deeply dissected. At the foot of the ountains the smooth floor of the basin passes into slopes deeply ncised by arroyos.

In the main the rocks of the Jornada basin form a synclinal trough Pl. II), but the dip of the beds is considerably greater than the ope of the land toward the center of the valley. As a result the eds are beveled, and toward the mountains on either side a thick

series of rocks is exposed wherever the surface gravels are removed. The basin is a destructional plain deeply covered by recent gravels and coarse deposits, with probably some lake sediments of limited extent.

Physiographically the bolson is very young. Erosion has as yet cut but little into the plain. The original constructional form of the present topographic cycle is everywhere in evidence. Only where the Rio Grande touches the borders of the plain have even the soft beds begun to wear out into lowlands.

Of the drainage little need be said. In general all waters flow toward the center of the plain and there are are no cross drainage ways. The numerous watercourses coming down from the mountains are quickly imbibed by the porous deposits and become "lost rivers." This is true also of the few small perennial streams as well as of the torrents which rush down the arroyos carrying only the storm waters.

On the west side of the basin the waters from the mountains do not drain out into the plains, but quickly disappear down deep canyons which debouch into the Rio Grande through gaps in the ranges.

In the central part of the basin are numerous shallow depressions into which the storm waters gather and form lakes of considerable size. Some of these retain their waters for several months and frequently through the year.

CENTRAL FLOOR OF THE BASIN.

As already stated, the Jornada presents the appearance of an almost level plain (Pl. III, A), slightly depressed in the middle. Closer inpection shows that the apparent smoothness is locally broken in various ways. The appearance of general evenness is due partly to optical illusion on account of the vastness of the field.

Low conical hills of volcanic origin rise above the plain at various points throughout its entire length. Most of these are unnamed, but some of the larger ones, especially in the southern part of the basin, have received specific designations. Dona Ana Hills, San Diego Mountains, and Cerro Robledo may be mentioned.

All of these volcanic cones are very recent, and some of them still have their craters perfectly preserved. Extensive basalt flows extend from some of the cones, one of which, located south of San Marcial, covers more than 100 square miles. Several remarkably symmetrical cones occur west of Engle station, near old Fort McRae. These are about 200 feet in height, while the Dona Ana Hills, for example, are more than four times this elevation.

EASTERN RIM OF THE BASIN.

On the east side of the Jornada basin is a ridge which rises abruptly to a height of 3,000 feet above the plain. While there are a number of low passes through the ridge, no one of these is low enough to serve as a drai[illegible] to the basin.

A. VIEW OF NORTHERN END OF THE JORNADA.

B. THE WHITE CLIFFS AT LOWER END OF ORGAN MOUNTAINS.

Shows Carboniferous limestone dipping west.

hrough great faulting on the eastern side of the ridge the various untain blocks have been tilted up so that the long back slopes form art of the broad syncline of the region to the west.

Beginning at the south these blocks have received the name of anklin Mountains, Organ Mountains, San Andreas Range, Oscura nge, and Chupadera Mesa. The last two ranges mentioned slope to e east instead of the west, the main fault passing between the Oscura d San Andreas sierras. Here two lofty fault scarps face each other, parated only by a comparatively narrow valley.

The characteristic aspect of the Franklin Range and the southern rgan Mountains is well shown by Peña Blanca (Pl. III, *B*). The main ass is composed of Carboniferous limestone and rises nearly 1,000 eet above the plain at the foot. The rugged character of the Organ lountains is well displayed by the contour map of the region.

The great fault scarp of the Sierra Oscura is a mountain block rising about 3,000 feet above the plain. In the lower three-fourths the granites and schists occur, and the long back slope is a heavy plate of blue Carboniferous limestone nearly 1,000 feet thick. Farther northward the eastern rim of the Jornada is formed by the Chupadera Mesa, which rises in an abruptly westward-facing escarpment several hundred feet high. The view of the escarpment shown in Pl. IV, *A*, is from the plain at a distance of 2 miles. The face of the escarpment is composed of Cretaceous sandstones, but a short distance back from the crest the surface of the mesa is made up of Carboniferous limestones. The sharp hill in the left foreground is a huge trachyte dike which extends away from the observer across the mesa a distance of 12 miles or more.

With the exception of the extreme northern portion the entire runoff of the eastern rim flows down the limestone incline to the foot of the ranges, then over red shales into the sandstone area forming the floor of the basin.

Since near the eastern ridge there is no large watercourse such as the Rio Grande, which flows along the western rim, the surface at the foot of the mountains presents but little of the relief that occurs on the western border of the plain.

WESTERN RIM OF THE BASIN.

Like the eastern side of the Jornada, the western side consists of high ridges trending north and south and dipping toward the basin. Geologically the western rim is similar to the eastern and of about the same height. There is, however, this difference: The western portion is broken at several places and the Rio Grande has begun to make inroads into the plain. Toward the south that stream crosses a part of the plain, forming the Mesilla Valley.

The mountains forming the western boundary of the plain consist at the south of a number of rather low, unnamed ridges, lying on the

western side of the Rio Grande. The Cerro Magdalena, southwest of Rincon, appears to be the most important of the ridges which lie west of the river. The Sierra de los Caballos and Sierra Fra Cristobal are large ranges, comparable to those on the east side of the plain. Continuing northward is a long line of mountains from 8 to 10 miles east of the Rio Grande, which extend almost unbrokenly for a distance of 50 miles to the Cerro Montosa. All of these mountains have a conspicuous fault scarp marking their western flank.

At the north end of the Sierra Fra Cristobal, where for a short distance the Rio Grande breaks the rim of the Jornada, erosion is beginning to cut into the plain and considerable indentation has been already made. By headwater erosion the small drainage ways (dry except in time of heavy rains, which happen only a few times each year) are rapidly cutting into the border. The local drainage for a distance of nearly a quarter of the way across the plain is now turned in this direction, and when the driving rains come powerful corrasion takes place along these arroyos. The Rio Grande is 800 to 1,000 feet below the plain, and the gradient of the arroyos is over 100 feet to the mile.

Other important gaps permitting the drainage waters of the plain to enter the Rio Grande are at the northern and the southern ends of the Caballos Range, and in the center at Palomas Canyon. The run-off of the Jornada side of this entire range is allowed to enter the Rio Grande instead of flowing out onto the plain and there sinking beneath the surface. A strip of country 4 miles wide on the average and 20 miles long thus drains into the Rio Grande. This belt is faulted in many places. It is traversed by basic dikes and is altogether a rough country. The difference in elevation of near-by points is often as much as 300 feet. The canyons are numerous and labyrinthine, with high gradients. Mescal Canyon and Palomas Canyon are the two master drainage ways, into which all others empty before their waters cross the mountain axis and fall into the Rio Grande.

The tops of the hills in this rough strip are nearly all on a level, which is the same as that of the plain projected westward. Consequently, when viewed from the railroad train, at a distance of about 12 miles, the plain appears unbroken to the very foot of the mountains.

In some places, as at the north end of the Sierra de los Caballos, are extensive lava beds which were poured out on the surface of the plain. Mescal Canyon cuts through one of these sheets, displaying fine sections of the beveled Cretaceous sandstones and the overlying gravels which once constituted the floor of the plain and which now form the floor beyond the limits of the lava flows. The bottom of the lava sheet is on a level with the tops of the hills of the neighborhood, also showing conclusively that at the present time erosion has progressed sufficiently to intricately and deeply dissect the country, but not far enough to destroy the last remnants of the Jornada's sur-

A. ESCARPMENT OF THE CHUPADERA MESA.

B. PEÑASCO ROCK.

face lying in this belt. North of this Mescal Canyon lava sheet is another similar one, a detached mass, known as Elephant Butte, near which is a reservoir site which, owing to prolonged litigation, has become one of the best known in the country.

At the south end of the Sierra de los Caballos the Rio Grande enters the Jornada and cuts a deep trench diagonally across this plain to the south end of the Franklin Range at El Paso. The distance is 65 miles. In passing through the central part of the plain the stream encounters several groups of volcanic mountains, which are known as the San Diego Mountains, the Dona Ana Hills, Cerro Robiero, etc. This part of the river's course is a rather narrow canyon, the sides of which exhibit many benches at various elevations above the present level, showing that the lava flows acted as temporary dams. In this part of its course the real nature and relationships to the great bolson of the country adjacent to the river are so disguised that many of its features are apt to be misinterpreted.

At Mesilla the valley of the Rio Grande broadens out into a wide flood plain, known as the Mesilla basin. The Atchison, Topeka and Santa Fe Railroad follows the banks of the Rio Grande for the entire distance from Rincon, where it comes down from the upland plain, to El Paso. From Rincon southward the western rim of the Jornada, while still high, is not so sharply marked as farther northward.

NORTHERN RIM OF THE BASIN.

At the north end of the Jornada the rim of the basin does not present the high mountainous aspects of the sides. There is, however, a broadly curved line of hills marking the boundary (Pl. III, *A*). These are 500 to 800 feet high, and are produced by upturned strata. This chain of hills is broken through at a number of points by deep arroyos, whose storm waters are soon lost in the plain.

At one place, near the west side, a broad, flat-bottomed valley several miles in width opens out to the northward. It extends in that direction many miles and appears to be continuous with the floor of the Estancia bolson farther north. The deeply dissected Chupadera Mesa forms the northeastern wall of the basin.

Beyond the rim a considerable area is drained into the basin through arroyos. The principal one of these watercourses is located near the center of the north wall, and is known as the Arroyo Chupadera. At the point where it cuts the rim, in a deep canyon, is located the Ojo Chupadera.

SOUTHERN SIDE OF THE BASIN.

The southern side of the upland Jornada plain is a mountainous belt of country extending in long finger-like projections across the national boundary from Mexico. These are the northern ends of several Mexi-

can ranges, the principal one of which is the Sierra de los Muleros. At El Paso the Rio Grande has carved its way through the hard mountain rock, forming a narrow canyon only wide enough to permit the passage of the river. At this point the east ridge is the southern extremity of the Franklin Range, which here represents the eastern rim of the basin. The high mountain to the west of the river is said to be marked by benches to a height of 800 feet above the river level.

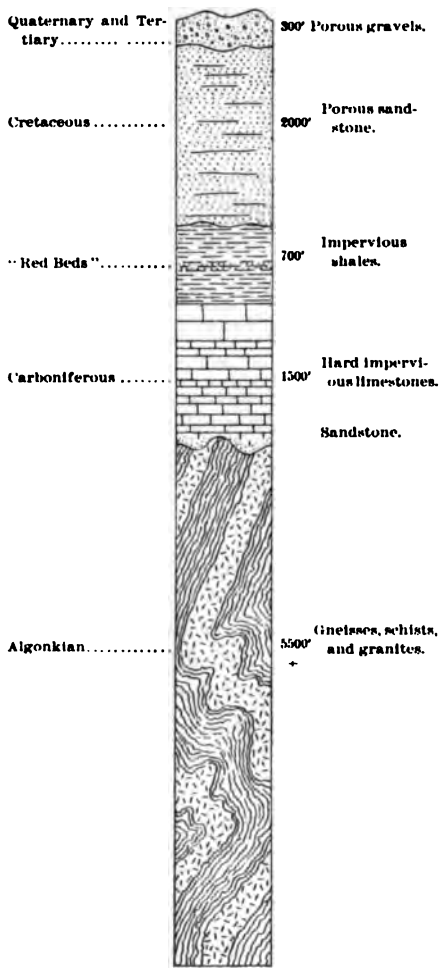


FIG. 2.—Geologic column.

West of the Rio Grande the normal character of the great plain is greatly obscured by late protrusions of volcanic materials. Conspicuous cones rise out of the plain at many points, and extensive lava sheets cover the surface.

THE FORMATIONS.

GENERAL GEOLOGIC RELATIONS.

The geologic formations of south-central New Mexico comprise five very marked classes of rocks (see fig. 2). At the base is a great mass of crystalline rocks, chiefly granites, gneisses, and schists, with some metamorphic rocks which can not always be directly distinguished from the members of the fundamental complex. These crystalline rocks are, in greater part at least, Archean and Algonkian in age. The later Paleozoic rocks are widely distributed, and are mainly thick blue limestones, mostly of Carboniferous age, which form chiefly the crests and back slopes of many of the principal mountain ranges. A third class of rocks is found in the thick and extensive beds of massive yellow sandstones of Cretaceous age. Over all these indurated rocks lies a mantle of soft clays, sands, and gravels, largely deposited during the late Tertiary and Quaternary periods. Later than all of these are outflows of igneous rock which also cover many thousands of square

.1. ELEPHANT BUTTE.

View taken from big bend in Rio Grande.

B. SOLEDAD CANYON, A MOUNTAIN ARROYO.

miles within the limits of New Mexico. The period during which these volcanic rocks were erupted extends from the early Tertiary down probably to within the time of the settlement of America by Europeans.

The stratigraphic relations of the several rock masses are represented in fig. 2. As will be noted, marked unconformities separate the different formations, the single exception being between the "Red Beds" and the Carboniferous. The geologic significance of these unconformities is of exceptional interest.

The thicknesses given are in all cases maximum measurements. The great thickness of the Tertiary gravels and the Cretaceous sandstones is found only in the middle part of the Jornada, and from this middle line there is a rapid diminution toward the eastern and western rims of the basin.

ARCHEAN SYSTEM.

In recent years geologic opinion regarding the crystalline rocks which underlie the great sedimentary succession in the New Mexico area has undergone some very radical changes, most of the extensive formations composed of granites, schists, gneisses, and slates, which form the core of many of the mountain ranges, being now classified in a later geologic age than the Archean.

It is thought that true Archean rocks are exposed only in the southern extremity of the Sangre de Cristo ranges within the boundaries of New Mexico. Possibly also some of the basement crystallines of the Mogollon and Burro mountains in western New Mexico and of the Sierra de los Caballos on the western rim of the Jornada may finally prove to be of Archean age. Even in these localities the areas which may be properly referred to the Archean are of limited extent.

ALGONKIAN SYSTEM.

Most of the mountain ranges of central New Mexico are huge tilted blocks, one side being a long slope and the other a steep face, originally a fault scarp. In the steep face a considerable portion of the basal part is often found to be made up of quartzites, micaceous and hornblendic schists, gneisses, and granites. The foliation of these highly metamorphosed rocks is usually nearly vertical. Where they are overlain by the basal quartzites and limestones above they are sharply beveled off, and the stratification of the sedimentary beds is nearly at right angles to the planes of lamination beneath.

For a long time it was thought that this crystalline complex represented the Archean. Late investigation has shown conclusively that many so-called "quartz veins" are in reality quartzites, and in thin section under the microscope this rock is seen to be of sedimentary character. Many of the dark-colored schists were without doubt originally basic intrusives, and some of the gneisses were granites

now profoundly sheared. These masses are frequently seen to be penetrated by later acid eruptives now forming vast irregular bodies and sheets of red granite, some of which probably are later than Algonkian.

These highly metamorphosed masses are referred to the Algonkian age. They are more or less mineralized in the various mountain systems, containing many of the extensive deposits of copper, iron, silver, gold, and some of the rarer metals. These rocks are well displayed in all of the ranges surrounding the Jornada plain.

The Algonkian rocks of the Grand Canyon section have not been recognized in New Mexico, and if they are represented it is not with the same characteristics and succession. It is possible, however, that more detailed study of the New Mexico field will disclose relationship to the Grand Canyon section. The main succession there is as follows: (1) Vishnu quartzite at the base, (2) Grand Canyon sandstone with interbedded and cutting basic eruptives, and (3) Chuar shales and limestones.

ROCKS OF EARLY PALEOZOIC AGE.

At present there is no reliable evidence that any of the lower Paleozoic beds are represented within the limits of the region under consideration. The great Cambrian, Ordovician, Silurian, and Devonian systems which are so extensively developed in other parts of the American continent have thus far not been observed in central New Mexico.

The Cambrian deposits, known elsewhere as the Tonto formation, and so well developed in the Grand Canyon district, may be represented in western New Mexico in some of the massive indurated sandstones. In central New Mexico, in the Sandia, Caballos, and San Andreas ranges, there is a massive quartzite 50 to 100 feet in thickness, the lower part of which is a conglomerate, but it is conformable with the overlying Carboniferous limestones. The quartzite member reposes upon the upturned edges of the Algonkian formations, indicating clearly that an enormous erosion interval separated the two. It would not be surprising if this erosion plane represents all except the latest Paleozoic sedimentation in other parts of the country. In some of the New Mexico mountain ranges this quartzite carries important copper deposits.

It was once believed that the formations subjacent to the great Carboniferous limestone were the metamorphosed beds of the lower Paleozoic; but this hypothesis does not now seem to have foundation.

CARBONIFEROUS SYSTEM.

The rocks of the Carboniferous system appear to be the only part of the great Paleozoic sequence that are represented in central New Mex-

A ORGAN MOUNTAINS, NEW MEXICO SHOWING BREAK OFF OR CHANGE IN TOPOGRAPHY.

B. VIEW SHOWING LOCATION OF CANAL LINE RUNNING ALONG SMALL RIDGES DIRECTLY BACK OF AGRICULTURAL COLLEGE.

ico. With the standard Carboniferous section for the American continent, as represented in the Mississippi Valley, the New Mexico sections do not as yet admit of detailed comparison.

The Carboniferous rocks of New Mexico are very important formations. They are found in most of the principal mountain ranges and in most localities they are important ore carriers. As guide horizons they deserve the fullest consideration in the location of all mineral deposits.

Four important formations belonging to the Carboniferous system have been clearly made out in the district under consideration. They are the lower Carboniferous, the middle Carboniferous, the upper Carboniferous, and the so-called Permo-Carboniferous. The three series of Coal Measures of the middle Carboniferous so enormously developed in the Mississippi Valley have not been differentiated in the West. They are, however, doubtless represented entirely by limestones.

The lowest series of the Carboniferous has been recognized in a number of localities. Among these places is one just outside of the area here mapped, in the vicinity of Lake Valley, which deserves special mention. Here has been found an extensive limestone series carrying a rich fauna identical with that of the lower Burlington limestone in Missouri, Iowa, and Illinois. Professor Herrick has also reported a similar lower Carboniferous from the east side of the San Andreas Range.

The great limestone sheets which cap the principal mountain ranges in south-central New Mexico, and which form their back slopes, are of upper and middle Carboniferous age. Immediately beneath these limestones is usually found a white quartzite which often passes downward into a coarse conglomerate. The quartzite with its coarse beds rests unconformably on the upturned edges of a metamorphic series, as already stated.

The great limestones are easily distinguished from all others of the region by their black and blue to gray colors, their peculiar compact texture, and the abundant characteristic fossils which they contain. The thickness of the formation is from 300 to probably more than 1,000 feet. They are everywhere massively bedded and some localities contain thick beds of very pure white limestone. In most of the principal mining districts the Carboniferous limestone carries important lead and silver deposits. The quartzite frequently carries copper.

In the Sandia Mountains, to the north of the district here described, several subordinate formations have been differentiated. The basal conglomerate and associated sandstones have been called the Sandia quartzite. The next member is a black limestone. According to the best available evidence derived from the contained fossils these beds correspond to the earlier Pennsylvanian of the Mississippi Valley.

The upper part of the great limestone formation—the blue to gray beds—contains an abundant fauna that clearly points to late Pennsylvanian age. In the Sandia Mountains this formation is called the "Madera" limestone. It forms by far the most important portion of the Carboniferous in all of the mountain ranges mentioned.

Above the great blue limestones of the Carboniferous there is an important sandstone, and then a sequence of shales and sandstones conspicuous for their remarkable red coloration. "Red Beds," they are generally called. These "Red Beds" are followed by other red beds scarcely distinguishable lithologically. The latter are believed to belong not to the Carboniferous, but to the Jurassic-Triassic.

The so-called Permo-Carboniferous red beds are found everywhere at the foot of the back slopes of the central New Mexico ranges. They are 200 to 1,000 feet thick, and often form a conspicuous feature.

In the Sandia Mountains the lower sandstone is called the "Coyote" sandstone, from Coyote Springs. There is an upper shaly member representing the Cimarron.

JURASSIC-TRIASSIC SYSTEMS.

There appears to be but small doubt that the upper part of the great formation long called the "Red Beds" belongs to a later geologic age than the Carboniferous, and the portion which occurs in New Mexico appears to be that termed in Kansas the Cimarron formation.

In New Mexico these beds are largely developed in the northeastern part in Cimarron, Canadian, and Pecos valleys, and in the central part in the Rio Grande Valley. The thickness probably is not greatly in excess of 500 feet.

CRETACEOUS SYSTEM.

The formations of Cretaceous age are the most extensive surface rocks in New Mexico, as they probably cover more than one-half of the whole area. Both the upper and lower Cretaceous sediments are well represented, but the serial sequence has not yet been definitely made out. The Jornada is everywhere immediately underlain by these rocks and they are the principal water carriers. In Canadian and Pecos valleys, particularly around the western and northern borders of the Llano Estacado, a remarkable sequence of sands, chalky rocks, and clays lies above the "Red Beds." These strata, comprising the Trinity sands, Fredericksburg limestone, and Washita sands, are thought not to be present in the district here described, and the Cretaceous begins with a formation believed to be the Dakota sandstone. This formation is at least 300 feet in thickness in this region and its basal sandstone is one of the chief water reservoirs. While not generally recognized, except in northeastern New Mexico,

ERNATIONAL RESERVOIR SITE. 2¼ MILES ABOVE INTERNATIONAL DAM SITE.

B. RIVER BED AT INTERNATIONAL RESERVOIR SITE.

View taken from big bend in river

; probable that the Dakota is widely distributed and is to be found ıort distance above the "Red Beds."

.lthough clearly differentiated in northeastern New Mexico in ticular, the Colorado formation is not so well defined to the south-'d. It comprises, chiefly, shales with numerous bands of limestone ı several thick sandstones.

\ttaining a development of 1,500 feet in northeastern New Mexico, Montana shales will doubtless be found to be well represented ·where in the Territory. Certain beds in the Jornada district are ıught to be the equivalents of this formation. The shales are mostly ıy and drab, becoming yellowish above and blackish below.

In New Mexico the beds generally referred to the Laramie forma-n are about 2,000 feet in thickness. The rocks are chiefly gray ıdstones and shales, with numerous beds of coal. Most of the Cre-:eous of the region between the San Andreas and Caballos ranges ·ms to belong to this age.

TERTIARY AND QUATERNARY SYSTEMS.

Eocene.—None of the sediments of the Jornada are as yet known to ·long to the Eocene. In the bordering region of the Rio Grande alley, however, there are large areas of gray shales and clays, reach-g a maximum thickness of over 800 feet, which have been referred ı the early Tertiary and are called the Puerco formation. A large ·rtebrate fauna has been obtained from them.

Later Tertiary.—The later Tertiary beds are widely distributed over ıe plateau region. In eastern New Mexico the Llano Estacado forma-on, over 100 feet in thickness, appears to belong to this age. A con-derable part of the sands and clay deposits underlying the bolsons oubtless belongs to the Tertiary, though as yet they have not been ifferentiated from the other unconsolidated deposits.

Quaternary.—To this age belong such beds as the bolson gravels, ıe arroyo gravels, alluvium, and many deposits of talus wash, besides ›me lake deposits.

The unconsolidated gravels and other surface deposits covering the lain of the Jornada del Muerto are probably in great part of com-ıratively recent origin. This opinion is based on the belief that the ·veled plain itself is of Tertiary age, and that consequently the pres-ıt topographic features are of recent date. The rock waste brought ›wn from the mountain slopes and carried out into the plain is of ›mparatively recent origin and its deposition is still in progress. pparently during Tertiary time the relief was less marked than at ·esent, and if any deposits were spread on the plain at that time they ere at best very meager.

The present unconsolidated surface deposits are of diverse origin. ›r the most part they are river deposits. Some are wind borne. A

few of very limited extent may be lake deposits, but of this there no direct evidence in the Jornada, though in other basins there ample evidence of extensive lake beds. There are some irregul beds which may be the fine, light débris known as volcanic a derived from some of the many volcanic outbursts in the region later geologic time. These superficial deposits do not appear to h near the enormous thicknesses that have been ascribed to them. I in places they are several hundred feet thick.

Most of the basaltic lava flows of the region doubtless belong to Quaternary period.

ERUPTIVE ROCKS.

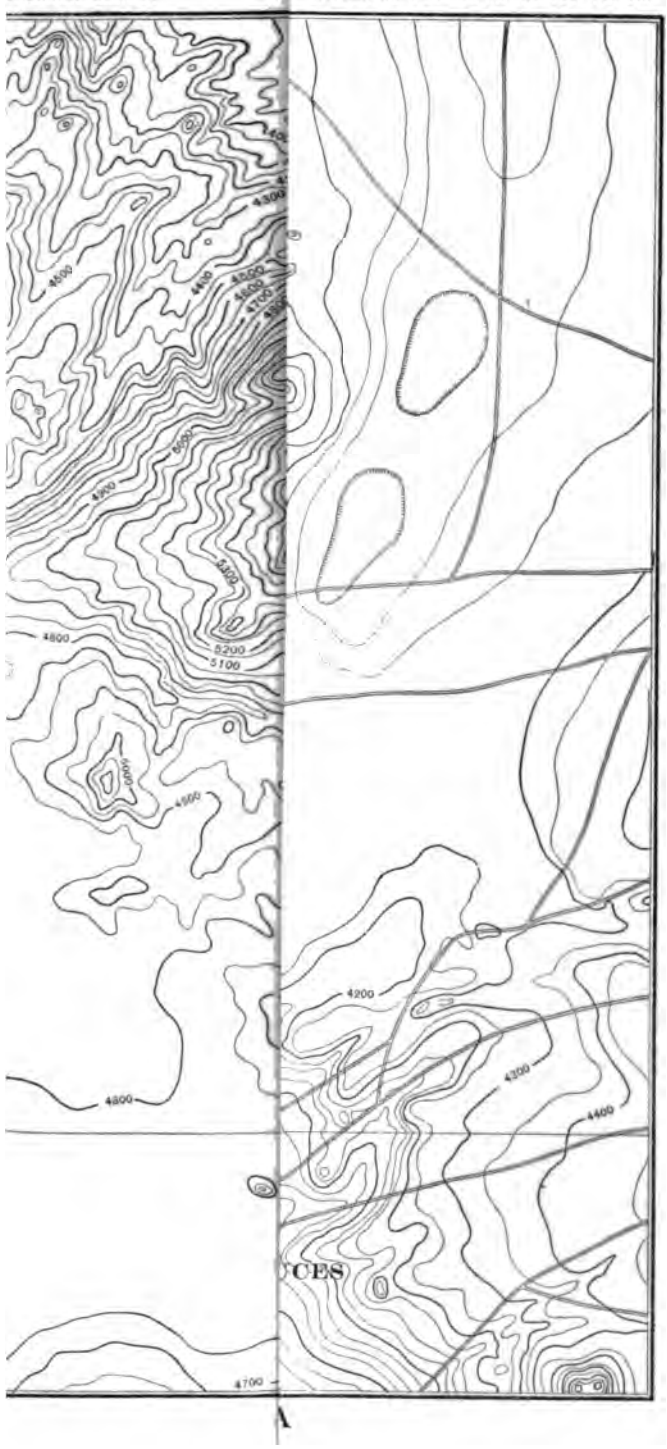
The eruptive rocks of the region are of three kinds. The most n worthy are the surface flows of black basalt, which often cover m square miles. The great sheet which begins immediately south of Marcial is perhaps the most extensive. It is of very late origin lies on several hundred feet of soft materials. In the Rio Gr bluffs at San Marcial the lava capping is now 300 feet above the ri The bluffs at this point are nearly perpendicular and form a stril feature in the topography. This lava flow probably at one dammed the river temporarily. Above the town terraces exten either side of the river for many miles and gradually approach water level in passing upstream.

Similar outflows from low volcanic cones occur at the northern of the Jornada northwest of Ojo Chupadera. West of Engle sta there are six or more low volcanic hills, none of them over 300 high, from which basalt flows extend for a distance of several m One cone 6 miles southwest of Engle appears to be the most import as from it a broad tongue of lava extends a distance of 12 mile more in a northwestward direction. This tongue is cut near its d extremity by the deep Mescal Canyon. Four of these cones appe be in a line running northeast and southwest. The rest are 5 to 6 n apart.

Toward the north end of the line of volcanic cones there is one f which a broad sheet of lava extends into the Rio Grande Valley. sion has deeply dissected the river bluffs and has in several pl isolated small areas of the original lava sheet which now form topped hills rising several hundred feet above the stream. On these isolated, lava-capped hills is widely known as Elephant Butt

In the southern part of the plain, south of Afton, on the Soutl Pacific Railroad, are similar lava flows covering many square mil surface.

South of the Elephant Butte region the country is traversed numerous basic dikes which are traceable for miles. So far as ca



1 Las Cruces sheet 1900

certained these dikes do not materially affect the water conditions, least so far as obtaining ample water supplies from shallow wells. some situations springs issue from the strata in the vicinity of the kes.

Of much older date are the trachytic and rhyolitic masses constitut- g the mountains near the point where the Rio Grande enters the ornada. The San Diego Mountains and the Dona Ana Hills are all this class. They rise abruptly out of the nearly level plain and rm conspicuous features of the landscape.

On the northern rim of the Jornada near Ojo Chupadera the rocks e traversed by numerous nearly parallel dikes of trachyte. These kes are 200 to 300 feet wide, trend northeast and southwest, are 2 to miles apart, and are traceable for miles across the country. In the inity of the dikes the rocks have been considerably disturbed, and some localities the plane of intrusion appears to be a fault, as nar- w belts of Carboniferous limestone are brought up into contact with etaceous sandstone.

STRUCTURE.

GENERAL CHARACTERISTICS.

n its general structure the Jornada bolson is a section of a pene- in-part of a vast Tertiary grade plain—formed on the beveled es of Mesozoic and Paleozoic strata (fig. 3). Through compara- ly recent deformation the boundaries of the present bolson have n defined by locally intensified mountain uplift.

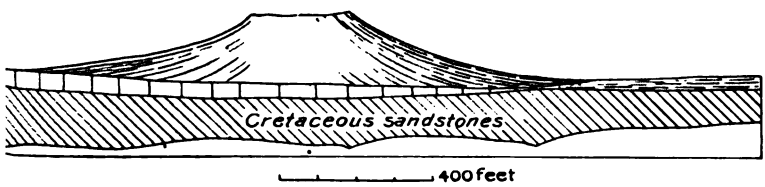


FIG. 3.—Mescal Cone resting on Cretaceous sandstones.

While in a general way the bolson under consideration is a broad, y shallow valley, and while with its rim abruptly upturned it has appearance of a simple syncline, it is a district in which the syn- al structure has been developed at different times and under some- at different conditions.

All the mountain ranges of central New Mexico may be considered simple monoclinal blocks, so tilted as to present one steep side and opposite side of more gentle slope. The crest and back slope of different ranges consist chiefly of blue Carboniferous limestones. ese limestones on the rim of the basin attain a thickness of over 00 feet, and are underlain by granites and gneiss.

In general structure, the ranges adjoining the great bolson plain of the Jornada del Muerto are of the characteristic mountain type known as the Basin Range structure. This feature is best illustrated by fig. 4, which is a cross section in an east-west direction transversely to the long axis of the bolson and embraces the mountain ranges on either side.

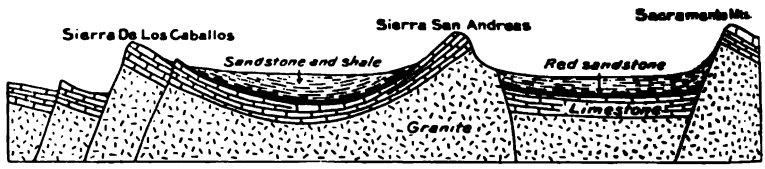


FIG. 4.—Basin Range structure of the Jornada.

In the various parallel bolsons and valleys which trend north and south through the high plateau region of New Mexico, the abrupt fault scarps on the sides face each other in some instances, while in others the longitudinal valleys are bounded by the long back slopes, giving the appearance of true synclines. The Jornada belongs in the main to the last-mentioned type. East of the Jornada is the great Jarilla bolson, a similar plain 150 miles long and 50 to 90 miles wide presenting opposed fault scarps on its longitudinal borders. To the west of the Jornada lies the Rio Grande Valley, which is similarly constructed, though now owing to the enormous erosion by the great stream the original plain effects are nearly obliterated. The general relations of the mountain blocks are more clearly represented in the cross sections in Pl. II. Near the mountains, especially on the west side of the plain, is a belt 3 to 4 miles wide, where the surface is trenched by intricately ramifying canyons, often several hundred feet deep, in which the formations are extensively exposed.

While the general slope of the plain toward the center is only 2° to 3°, the dips of the strata are often as high as 30° in the same direction, and in places they are vertical. On the beveled edges of the steeply inclined beds the plain gravels are laid down, and also broad sheets of basaltic lava, the latter spreading out from numerous low cones (see fig. 3).

The general synclinal character of the bolson holds good for only part of the Jornada. At its northern end the synclinal feature is completely lost. A monoclinal structure is present—steep on the western rim of the basin, but soon flattening out to nearly a dead level eastward to the foot of the Sierra Oscura, where there is a fault 3,000 feet.

STRUCTURAL RELATIONS OF THE FORMATIONS.

The rim of the Jornada basin consists of limestones of Pennsylvanian age, which in the center of the synclinal trough lie beneath the su

A. ORGAN MOUNTAINS, NEW MEXICO, SHOWING A PORTION OF THE MOUNTAINS.

B. *NATURAL DIKE NEAR* ELEPHANT BUTTE.

face at a depth of more than 2,000 feet. Under these limestones are the crystalline schists and gneisses with intrusive granites. The formations to be considered with respect to the underground water conditions are those lying above the Carboniferous limestones and the overlying "Red Beds." These are the Cretaceous sandstones and the mantle of porous, unconsolidated deposits which everywhere cover the country occupied by this plain.

These several geologic terranes, embracing all between the basal crystallines and the loose surface deposits, recline upon one another without discordance in dip. It is possible that marked unconformities exist locally between some of the sedimentary rocks, but as yet no evidence of the existence of these conditions has been found.

DESCRIPTION OF CROSS SECTIONS.

The geologic cross sections of the Jornada are especially instructive in their direct bearing on the underground water conditions. Three of these cross sections (Pl. II) suffice to represent the general conditions. These are called the northern, middle, and southern cross sections, and their locations are indicated on the geologic map (Pl. I), although their extremities extend somewhat beyond the area shown on this map. Each of the cross sections is about 50 miles long. The vertical scale in feet is given at the side of the drawing, as are also the heights above sea level.

Northern cross section.—The northern section (section A–A on Pl. II), which may be called also the Socorro cross section, extends from the San Augustine Plains west of the Magdalena Mountains, through the old Socorro Volcano and the high range of hills on the east side of the Rio Grande, to beyond the Sierra Oscura. The Jornada lies between the last-mentioned range and the high hills bordering the Rio Grande on the east.

In this part of its extent the substructure of the Jornada plain is a monocline abutting against the Oscura Mountains. The latter rise abruptly out of the plain and for more than three-fourths of their height present crystalline rocks in the face of the escarpment they form.

Middle cross section.—The middle section (section B–B, Pl. II) may be called the Palomas section, since the famous Palomas Canyon which bisects the Sierra de los Caballos is in its line. This is the most typical cross section of the Jornada plain. It shows a simple synclinal structure, with profound faults on the opposite sides of the marginal mountain ranges in either direction.

On the Rio Grande side of the Caballos Range repeated faulting is indicated—the river occupying the minor fault block next to the great fault block of the main mountain ridge.

The highest part of the Caballos Range exhibits very clearly th evidences of a profound thrust plane, the geologic age of which greatl antedates the period of normal block faulting which gives the preser characteristic aspect to the region. The Carboniferous limestone for three-fourths of the distance to the summit of the range stan nearly vertical. Erosion has beveled the edges of the upturned bed at angles of about 35°—the slope of the eastern side of range. Th gives an appearance of great irregularity to the rocks, except at th top of the mountain, where horizontal beds cap the summit. Th appearance is almost inexplicable until the existence of the fault thru is recognized.

Immediately east of the western rim of the bolson and between th Sierra de los Caballos and Sierra Fra Cristobal are small lava cones 30 to 400 feet high, each of which has sent out a basaltic flow for seven miles in all directions. These flows appear to cover some of th earlier mesa gravels, and they are probably early Pleistocene in ag

The gentle syncline of the Jornada is, perhaps, its most characte istic structural feature. It is to be noted, however, that this regio is not a simple trough, but a syncline which has experienced repeate or rather continued, upturning of its margins while the process c general base-leveling was going on.

In the San Andreas Range there is found a simple monoclinal bloc with profound faulting on the eastern flank of the range. From th foot another broad bolson plain extends to the lofty Sierra Blanca.

Southern cross section.—The Las Cruces section (Pl. II, sectio C–C) presents a number of features not displayed in the other tw sections here mentioned. The Jornada continues to be a synclin trough, but the Rio Grande has cut across the disturbed zone of th western rim and traverses the great bolson itself.

The Organ group of mountains, which forms a part of the easter rim of the Jornada basin, is a mass of old crystalline rocks which, o account of special local conditions, has been thrust upward much mo than any other part of the plain's periphery, and has been completel denuded of the sedimentary rocks, except at the very base of th range. Rising abruptly out of the plain half way between the Orga Mountains and the Rio Grande is Tortugas Hill, a small tilted lim stone block.

SOME MINOR STRUCTURAL FEATURES.

The region to which this report relates exhibits many details c structure that probably are of sufficient interest to merit special notic here. Among the phenomena of this kind to be mentioned are faul ing, jointing, folding, and fissuring. Most of the features are in th rim of the basin, and on the east slope of the Sierra de los Caballc are exemplifications of many interesting structural details.

Reversed faulting.—There is abundant evidence that while the present mountain uplifts are the products of normal faulting, this region has been subjected to some tangential pressure, causing overthrust faults. These occurred long after Carboniferous time, because they involve rocks of that age. Possibly some of the main lines of uplift of the present mountain ranges were initiated by the lines of weakness marked by the thrust planes.

In the Sierra de los Caballos the phenomena of reversed faulting are exceptionally well displayed. The east slope of the range presents some excellent examples on a small scale. One in which the throw is only 50 feet is represented in fig. 5.

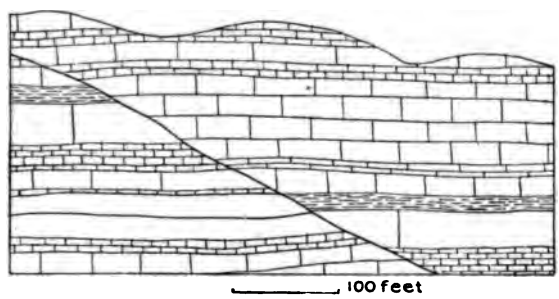


FIG. 5.—Small reversed fault in western rim of Jornada.

On the other hand, the immense thrust plane under the Caballos cone may represent a movement of one or more miles. It is clearly exposed, with relations shown in fig. 6.

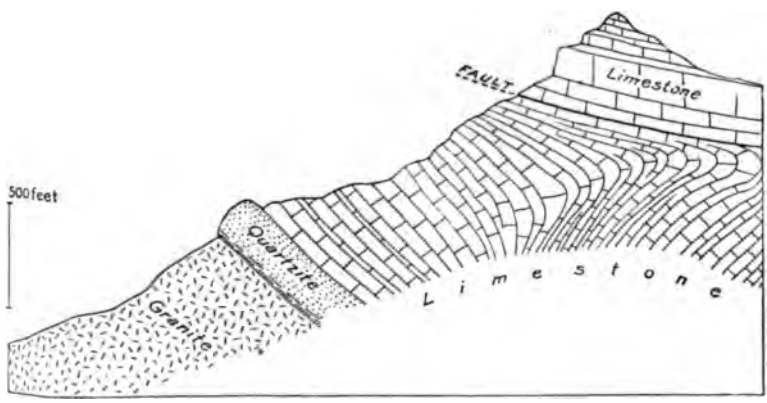


FIG. 6.—Caballos Peak and thrust plane.

The tremendous effects of the tangential pressure of this period are further indicated in Las Palomas Canyon, where the strata are greatly corrugated and folded.

Normal faulting.—The normal faults are of two series, of which the major produced the present monoclinal blocks forming the east

and west sides of the great basin. These have a throw of about 4,000 feet, and give the Basin Range structure to the region.

A minor series of normal faults trends at right angles to the axes of the mountain ranges. They were produced probably in the warping of the great limestone masses which form the main portions of the

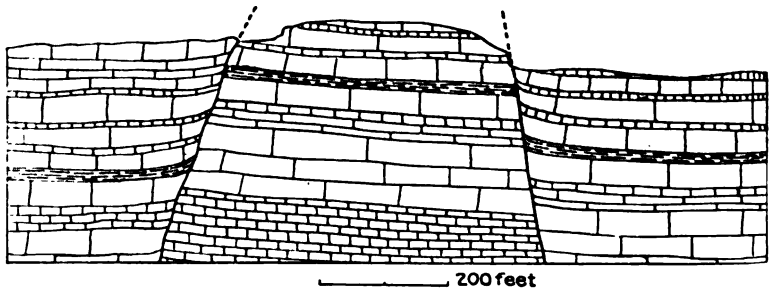


FIG. 7.—Normal faulting at Napoleon mine.

mountains. That some of these transverse faults, even those of comparatively small throw, affect great thicknesses of rock is shown by the fact that some of them are associated with true fissure veins of lead and copper ores. A cross section at the Napoleon mine is given in fig. 7.

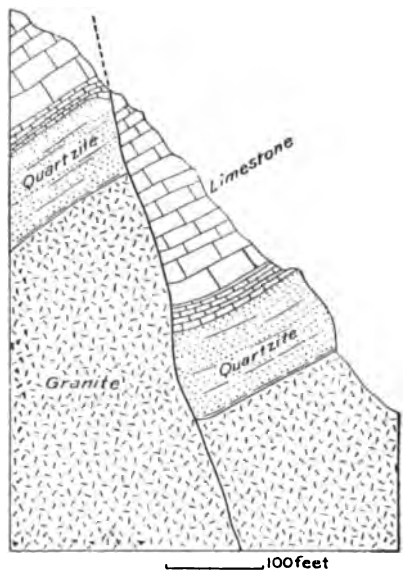


FIG. 8.—Normal faulting at El Capitan mine.

Another good illustration is at El Capitan mine, which is opened near the base of the unaltered sedimentary sequence, one side of the tunnel being the limestone and the other the crystalline complex (see fig. 8)

:r feature of faulting is associated with the basic dikes which
›r miles across the country east of the Caballos Range and near
nic cones already mentioned. In some cases the dikes do not
› have disturbed the sandstones in which they occur, but
pread apart the two walls. A good example is shown in
'anyon, below the spring of the same name. This is repre-
fig. 9.

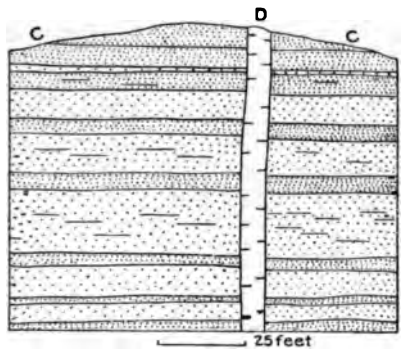


FIG. 9.—Basic dike in Cretaceous sandstone.

are often springs issuing from the base of the canyon walls
ımediate vicinity of dikes of this description. It may be that
› act as dams for the underground waters and serve to pond
On the other hand, some of these dikes greatly disturb the
es for a distance of several hundred feet. This is best illus-
y fig. 10.

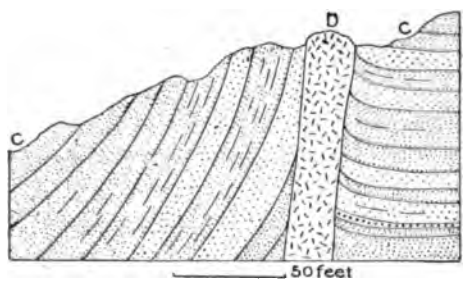


FIG. 10.—Basic dike disturbing level sandstones.

nore prominent are some of the dikes on the northern border
›rnada, east of the Ojo Chupadera. The relationships of the
: shown in fig. 11.
'lar dike is shown in Pl. IV, A, page 16. It cuts and upturns
›oniferous limestones; but between the time of its intrusion
of the deposition of the Cretaceous sandstones the whole
'as elevated and beveled off.

In these cases the direct influence of the dikes in the local water storage underground is traceable. At various points springs issue from near the line of contact of the dike rock and sandstones. This

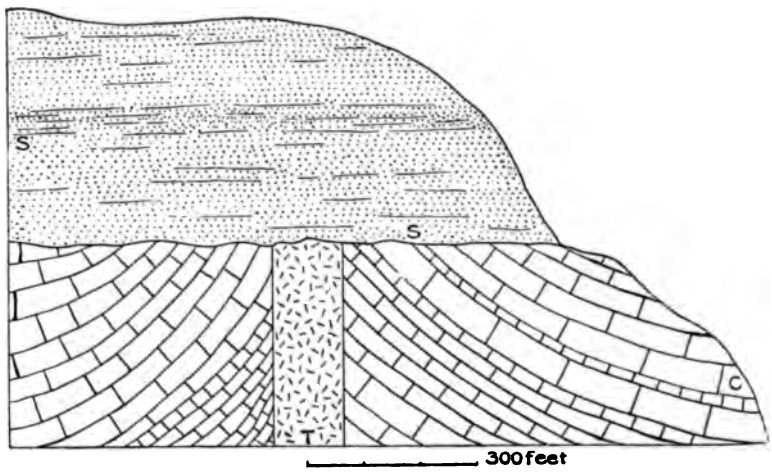


FIG. 11.—Acidic dike in Carboniferous limestones.

is especially noticeable wherever the rocks are slightly tilted. Reference will again be made to these various features in their bearings upon the local water supply.

UNDERGROUND WATERS.

GENERAL CONSIDERATIONS.

It will be seen from the foregoing description of the geologic relations that the Jornada del Muerto is underlain by extensive deposits of permeable materials. As the greater part of the rainfall sinks into these deposits, it is certain that they contain waters which are available for wells of greater or less depth. The appearance of a waterless waste which this plain presents loses much of its discouraging aspect to the settler when the real conditions are presented.

The peculiarities in geologic structure, composition and arrangement of materials, and climatic conditions of the Jornada are similar to those of the other bolson plains of the region, including western Texas. The observations of Hill[a] on the Texan area are so directly applicable to the area under consideration that several paragraphs are here quoted. He says:

The influence of structure and imbibition is shown in the basin plains. Although unconsolidated, the rocks of the basin plains are alternations of porous and impervious beds, and hence are valuable artesian areas; by experimentation in boring properly selected sites considerable water may be obtained. Nonflowing wells ha

[a] Hill, R. T., Final Rept. Artesian and Underflow Investigation, U. S. Dept. Agric., pt. 3, 1892, p.

n secured in many of the most unpromising plains, even in Death Valley; as nishing water for stock, these wells are very important.

'he geologic age of strata is of secondary importance in determining the occur-.ce of underground water. Approximately the same amount of rain falls upon a at diversity of country, some of which contains great stores of water, while other 'ts are entirely lacking in this essential. For instance, the mountains of the trans-:os region are mostly composed of hard, impervious rocks—compact limestones, artzites, and eruptive rocks. Less than 1 per cent of the rain falling upon these 'ks is absorbed, except such as finds its way into the structure by cracks and fis-'es or along lines of contact. As a result of this condition the water after every ower quickly flows down the slopes to the extensive flats which occupy the valleys tween the mountain ranges. These flats, as well as the entire surface of the Llano tacado, have a structure entirely different from the adjacent mountains, and are r the most part composed of loose, porous sands and gravels, so that every drop of in that touches their surface is immediately absorbed and does not flow off in 'eams. This explains the utter absence of running water on the surface of these ts and its abundance stored in the structure beneath. Not only does this basin d plain formation imbibe all the rain which falls upon its surface, but the great rrents which pour down the mountain sides and canyons disappear immediately on reaching the plain, being imbibed by its porous structure. The constant 'eams also which flow from the snow-clad peaks or mountain springs, such as the 'ven Rivers, the Tularosa, and the numerous lost rivers of New Mexico and Texas, iickly disappear upon reaching the plain.

After the rain ceased an observer would be impressed by the fact that the repre-ntative rocks of the different areas exhibited capacities different not only for imbib-g water, but also for transmitting it through their structure by percolation, and ose rocks which imbibe the least water, like the limestones, porphyries, and quartz-'s of the Organ, the Guadalupe, and other trans-Pecos mountains, most slowly ansmitted it, so that for days, perhaps months, springs and seeps flow from the evices and contact plains of the high mountain slopes, keeping alive delicate ferns d rare plants. On the surface of the Llano, except where slight quantities of clay e mixed with sandy loam, in an hour or two there remains little evidence in the y surface that a shower has fallen, the water having quickly penetrated to the pths beneath.

AREAL DISTRIBUTION OF THE WATER-BEARING BEDS.

By reference to the geologic map (Pl. I) the areal distribution of e several geologic formations will be seen. The greater part of e area is underlain by Cretaceous sandstone, which occupies the ddle portion of the Jornada, probably four-fifths of the plains, and more than 25 miles wide in places. On either side is a belt a mile two broad of "Red Beds," chiefly impervious clays. Then come the rboniferous limestones, forming the rim of the basin in a belt about iiles wide. Except in the Sierra Oscura and the Organ Mountains, crystalline rocks are exposed on the bolson side of the area.

'hese various belts of formations extend in nearly parallel strips ng nearly the entire length of the Jornada del Muerto district. eir proper recognition is necessary for an understanding of the lrologic conditions to be expected in any particular part of the basin. s is especially true of the marginal portions of the area.

AREA OF WATER SUPPLY.

The most important feature to be taken into consideration in connection with the area of possible water supply is the fact that the collecting ground is not confined to the marginal mountains, as in many other regions, but the bolson imbibes all the water falling upon the surface. The underground reservoirs may be at different geologic horizons and at different depths from the surface, but, with the exception of a comparatively small amount of water which finds its way into the Rio Grande, all the rain finds lodgment in some part of the several porous formations.

As most of the mountain rock is hard and impervious, much of the rains run off the mountain slopes in torrents, which, as they spread out over the plain, are soon imbibed by the unconsolidated surface deposits. The arroyos of the Caballos Mountains carry streams 10 feet deep in time of heavy rainfall, flowing with terrific force and carrying away nearly all of the water, which is shed completely by the hard rocks on the mountain slopes. In the San Andreas Range these torrential waters are being stored for irrigation purposes in the adjacent plain below.

CLIMATIC CONDITIONS AFFECTING WATER SUPPLY.

As the Jornada is within the semiarid belt it presents characteristics not found in more humid regions. The total annual rainfall is about 12 inches, though in the mountainous rim, which rises 3,000 feet above the plain, the precipitation probably exceeds 15 inches a year.

The precipitation is mainly rain, but occasionally is in the form of snow, which covers the ground to a depth of 2 to 3 inches, but disappears in a few hours. Most of the rain falls during the months of July and August. Evaporation amounts to about 90 inches annually, and is facilitated by the dry air, high winds, and scant vegetation.

PERMEABLE STRATA.

One of the geologic peculiarities in the Jornada del Muerto is that it is in greater part overlain by unconsolidated porous deposits. These are the loose bolson gravels and sands which cover the underlying formations to considerable depth. Under fully two-thirds of the entire area of the plain the Cretaceous sandstones lie immediately beneath these bolson surface deposits. The next porous stratum is in the basal portion of the beds, where immediately above the Carboniferous limestones there often are beds of coarse sandstone.

There are, then, three distinct formations which permit the underground circulation of water. As these permeable formations extend throughout the whole Jornada, except a narrow belt around the mountainous rim, it is easy to understand the reason for the phenomenon o

a basin containing nearly 10,000 square miles, with an annual rainfall of 10 to 12 inches, yet having a total absence of running streams. Aside from the portion of rainfall which is evaporated, the whole of the annual precipitation is imbibed by the spongy surface formation, and percolates downward until it encounters some clayey layer or other impervious stratum.

WATER HORIZONS.

The water horizons in the three formations above described are as follows: (1) At the base of the bolson gravels, (2) at the base of the Cretaceous sandstones, and, locally, (3) at the base of the "Red Beds." These are the horizons from which artesian flows are most likely to be obtained. There are, however, other minor horizons in the bolson gravels and sands and Cretaceous sandstones, to which wells may be sunk to secure ample water supplies.

The depth to which it is necessary to bore in order to reach the base of the bolson gravels and sands, which form the first of the principal artesian horizons, varies greatly. The thickness of these gravels has manifestly been greatly overestimated, as all recent data indicate that they probably nowhere exceed a thickness of about 150 feet.

Shumard,[a] one of the pioneer scientists, who traversed the Jornada in 1856, makes the following statement:

> Wherever examined, the surface formation was found to consist of detritus of rock débris, in all respects the same as those composing the neighboring mountains from which it was doubtless mainly derived. The precise thickness of this deposit could not be very accurately determined, as only a few natural sections were observed and these only near the base of the mountains. In two localities its observed thickness was nearly 500 feet.
>
> Geologically speaking, the Jornada del Muerto may be considered as nothing more than a single trough composed mostly of limestones, sandstones, and shales, and covered to the depth of 500 or 600 feet with loose detritus.

There is no place along the Jornada in which there is a section of bolson gravels showing any very great thickness. As these gravels slope down from the marginal mountains, the first inference would naturally be that the incline was produced by filling up by the gravels on a level plain. This is not the case, for the gravels lie on a sloping surface and their thickness is not great along the slopes, as might at first glance be expected.

Waters from wells sunk in the Cretaceous sandstones are especially satisfactory. Most of the waters of the Jornada del Muerto now in use are "hard," as they often contain relatively large amounts of lime in the form of the carbonate and the sulphate, but the actual amounts of these compounds is surprisingly small when the source of the water is considered.

---

[a] Shumard, G. G., Structure of the Jornada del Muerto: Trans. St. Louis Acad. Sci., vol. 1, 1858, p. 341.

Some analyses of waters from an adjoining bolson, the Ests plain, which presents almost identical geologic conditions, illus the point. These results of analyses are introduced for the re that they represent even more extreme conditions than those in Jornada. The analyses were made by Prof. F. C. Lincoln, of New Mexico School of Mines.

Chemical analysis of well water at Stanley, N. Mex.

[In grains per United States gallon.]

Probable compounds:	
Organic and volatile matter	
Silica	
Alumina and ferric oxide	
Calcium carbonate	
Calcium sulphate	
Calcium chloride	
Magnesium carbonate	
Magnesium sulphate	
Magnesium chloride	
Potassium carbonate	
Potassium sulphate	
Potassium chloride	
Sodium carbonate	
Sodium sulphate	
Sodium chloride	
Total solids	

Chemical analysis of water of spring-fed lake at Estancia, N. Mex.

[In grains per United States gallon.]

Probable compounds:	
Organic and volatile matter	
Silica	
Alumina (with ferric oxide)	
Calcium carbonate	
Calcium sulphate	
Calcium chloride	
Magnesium carbonate	
Magnesium sulphate	
Magnesium chloride	
Potassium carbonate	
Potassium sulphate	
Potassium chloride	
Sodium carbonate	
Sodium sulphate	
Sodium chloride	
Total solids	

WELLS OF THE JORNADA DEL MUERTO.

The wells of the region are of three classes, viz, shallow dug wells, deep drilled wells, and flowing wells.

The first important well in the Jornada del Muerto was sunk by John Martin in 1871. He dug a hole 160 feet deep in the middle of the plain and found a plentiful supply of good water. From that time onward Martin's ranch became the stopping place of every party crossing the then dreaded basin.

During the more than thirty years which have passed since the first well was dug a large number of wells have been sunk in nearly every part of the region. They rarely go down more than 50 to 75 feet, and the water is raised chiefly by windmills.

When the location is selected with consideration of topographic and geologic conditions, it is quite likely that there are but few spots in the Jornada which would not furnish adequate supplies of water for all purposes to which the surrounding country is adapted. Most of the wells are now dug in the mesa gravels, but where they are in the Cretaceous sandstones there is apparently a larger flow, due probably to the more homogeneous texture and more uniform porosity of the formation.

It is probably unnecessary to mention in detail the various dug wells, as they are so numerous and the phenomena presented are so much alike everywhere within the area. Practically nothing has been done to develop water supplies by means of deep wells, though the conditions appear favorable for abundant water from this source. The only serious attempt to sink a deep well within the limits of the Jornada appears to have been at a point a short distance northwest of Engle, a station on the main line of the Atchison, Topeka and Santa Fe Railroad, on the high plain about halfway between San Marcial and Rincon. Engle is 300 feet above the first-named station and 700 feet above the second.

This well was drilled by the railroad company to a depth, as reported, of 1,200 feet. A good artesian flow was obtained, but the water was unfit for locomotives. The casing was withdrawn and the hole plugged at a depth of about 150 feet, where softer water is obtained. This water does not rise to the surface, but has to be pumped about 50 feet. The discharge goes into a large reservoir and is then piped to the station, about 2 miles distant. The present water supply appears to be obtained from the base of the mesa gravels. At a depth of 1,200 feet this boring probably failed to reach the base of the Cretaceous sandstones, the horizon in which artesian flows of good water may be expected.

A number of shallow wells are practically flowing wells. They have been dug near springs in some cases, and when properly curbed the

overflow is conducted through iron pipes farther down the valley. Such, for example, are some of the wells near the foot of the Caballos Range.

QUALITY OF THE UNDERGROUND WATERS.

In the arid regions the waters are so generally spoken of as "alkali waters" that many persons suppose that this character is the prevailing one. In most cases, however, the underground waters of such bolsons as the Jornada are often sufficiently good for domestic use. The so-called "alkali," which often appears as a thin white coating in places where the water has evaporated, in most cases consists chiefly of common salt. Of the large number of well waters examined from the Jornada comparatively few were found to be unpalatable and with a few exceptions, all were excellent for stock and for domestic purposes.

RÉSUMÉ OF UNDERGROUND WATER PROSPECTS.

The geologic conditions of the Jornada indicate that the most important water-bearing stratum lies at the base of the Cretaceous sandstone. How extensive this stratum is can only be determined by a few properly located drill wells; but all available data lately collected go to show that this water supply should be very considerable.

Since the trough of the basin pitches southward about 12 feet to the mile, it is questionable whether the artesian conditions extend beyond the southern half of the region. The deep well and a number of shallow wells in the sandstone near Engle indicate that artesian conditions exist at least that far north.

The dips in the synclinal trough of the Jornada are such that the main water-bearing stratum lies from 1,000 to 2,000 feet beneath the surface in the center of the valley, but rises rapidly on each side until at a distance of from 10 to 12 miles on either side the water horizon reaches the surface under the gravels. The probable distance that it is necessary to drill in order to penetrate the principal water stratum may be thus estimated approximately. Moreover, there is another important and easily recognizable horizon which serves as a guide plane beyond which no one should go in his search for flowing water. The impervious "Red Beds" underlie the yellow sandstone of Cretaceous age and effectually prevent water from sinking lower. This important fact should always be borne in mind in sinking deep wells, and it is also believed to be useless to seek for water in the "Red Beds." When the drill penetrates these beds sufficiently to establish their identity the boring should be abandoned.

There are also local conditions that interfere with the artesian flow. Some of these obstructions have already been considered at length, but they should be regarded as of but limited extent and when met with a locality should not be condemned on account of a single failure.

The water-bearing stratum at the base of the mesa gravels is less clearly defined than that at the base of the Cretaceous sandstone. It is not likely to furnish flowing wells except in a few favored localities. Its main value is in furnishing the water supply for shallow, dug wells. Another point to be taken into consideration in connection with the water horizon of the mesa gravels is that in many places impervious clays separate the gravel beds. This brings important water-bearing levels much nearer the surface than would be ordinarily expected.

It is now a well-known fact that in the Mesilla Valley, where the Rio Grande traverses the Jornada plain, there is a vast underflow, from which water may be pumped in great volume for irrigation. As the Cretaceous sandstones rise near the surface in the Mesilla Valley, it is possible that a part of this underflow may be derived from the artesian stratum at the base of the Cretaceous sandstone, but it is here mainly in the Quaternary gravels filling the valley.

IRRIGATION.

Regarding the possibilities of the Jornada as a district for irrigation by well waters much might be written. It is possible that by systematic development many thousands of acres may be reclaimed for agricultural purposes. From artesian wells or even deep-drilled wells where pumping would have to be done, the outlook appears favorable for the irrigation possibilities. It is estimated that eventually at least one-tenth of the region should be brought under cultivation. The waters of the Rio Grande can be made available for the irrigation of large areas and the Elephant Butte reservoir at the end of the Sierra Fra Cristobal, now in contemplation, will bring an extensive portion of the flood plain under irrigation.

By the construction of reservoirs in the mountain arroyos along the elevated margin of the plain, many local areas may be brought under cultivation. Some of these reservoirs have already been planned or are under construction. Their success will certainly encourage many others to be built, and eventually a large strip of country bordering the mountain ranges, which at present is mostly used as grazing land, will thus be irrigated.

INDEX.

Page.

ı near 24
rocks, occurrence and character of 18–20
urrence of 38
ocks, occurrence and character of 18–19
urrence and character of 14, 24
ge structure, figure showing 26
ence of 26
aracter of 11
ıg of name of 11
round water in 32–39
ı limestone, correlation of 21
ntains, rocks of 19
ierra de los, dikes near 31
ge of 34
n 28–29
ıre showing 29
n of 16
f 19
River, character of 12
ın 22
w of 20
ous rocks, dike in, figure showing 32
ence and character of 15, 18, 20–22, 25, 33
formation, occurrence of 22
River, rocks of 22
les, occurrence of 20
ı, Arroyo, location of 17
ı Mesa, location of 15, 17
f 16
ormation, occurrence and character of 23
tiver, character of 12
dstone, occurrence of 22
ı rocks, dike in, figure showing 31
ence and character of 15, 18–19, 22–23, 27, 33–34
n 35, 37–39
ıdstone, occurrence and character of 22–23
res showing 31–32
ence of 31–32
Hills, location of 14, 17
f 25
character of 14, 17, 35
ı mine, faulting at, figure showing 30
Butte, dike near, view of 26
ıear 24–25
ıir near 17, 39
f 18

Page.

Engle station, volcanic cones near 14, 24
well near 37–38
Eocene rocks, occurrence of 23
Erosion, progress of 14, 16, 24
Estancia, spring water at, analysis of 36
Estancia bolson, location of 13, 17
Faulting, figures showing 29–30
occurrence and character of 29–30
Fort Selden, view near .....
Fra Cristobal, Sierra, location of 16
Franklin Mountains, location of 15, 18
Fredericksburg limestone, occurrence of 22
Geologic column, figure showing 18
Geologic formations, classes of 18
figure showing 18
occurrence and character of 18–25
permeability of 34–35
Geologic structure of region 25–32
Geology of region 18–32
Grand Canyon district, rocks of 20
Grand Canyon sandstone, occurrence of 20
Herrick, C. L., on Carboniferous of New Mexico 21
Hill, R. T., on bolsons 32–33
Igneous rocks, age of 19
occurrence and character of 14, 16–19, 24–25
International reservoir site, views of 22
Irrigation, prospects for 39
Jarilla bolson, location of 26
Jornada del Muerto, age of 13
area of 35
character of 10
location of 9–10
map showing 9
meaning of 10
view in 14
Journey of Death. *See* Jornada del Muerto.
Jurassic-Triassic rocks, occurrence of 22
Lake Valley, rocks of 21
Laramie formation, occurrence and character of 23
Lava, occurrence of 16–17
Lincoln, F. C., analyses by 36
Llano Estacado, area of 12
Llano Estacado formation, occurrence of 23
Madera limestone, occurrence of 22
Magdalena, Cerro, location of 16
Map, geologic, of region 10
Martin, John, well sunk by 11, 37
Mescal Canyon, dike in, figure showing 31
location and character of 16
Mescal Cone, section of, figure showing 25
Mesilla Valley, location and character of 13, 15, 17

Page.
Mesilla Valley, underground water in..... 39
Mogollon Mountains, rocks of..... 19
Montana shales, occurrence and character of..... 23
Montosa, Cerro, location of..... 16
Muleros, Sierra de los, location of..... 18
Napoleon mine, faulting at, figure showing. 30
New Mexico, geologic formations of..... 18
New Mexico plateau region, character and history of..... 11-13
Ojo Chupadero, rocks near..... 25
Organ Mountains, cliffs of, view of..... 14
location of..... 15
rocks of..... 28
views of..... 14, 20, 26
Oscura Range, location of..... 15
Paleozoic rocks, occurrence and character of..... 18, 20
Palomas Canyon, location and character of. 16
Pecos River, character of..... 12
rocks on..... 22
Peña Blanca, location and character of.... 15
view of..... 14
Penasco Rock, view of..... 16
Pennsylvanian rocks, occurrence of.... 21, 26-27
Puerco formation, occurrence and character of..... 23
Quaternary rocks, occurrence and character of..... 18, 23-24
Rainfall, amount of..... 34
Red Beds, occurrence of..... 22, 33, 38
Reservoirs, storage, construction of..... 39
Rhyolite, occurrence of..... 25
Rio Grande, bolsons near..... 12-13
character of..... 12-13, 18
course of..... 17
irrigation from..... 39
reservoir site on, views of..... 22

Page.
Rio Grande, valley of, character of..... 26
Roblero, Cerro, location of..... 14, 17
San Andreas Range, location of..... 15
rocks of..... 20-21, 28
water of..... 34
San Diego Mountains, location of..... 14, 17
rocks of..... 25
San Marcial, rocks at..... 24
Sandia Mountains, rocks of..... 20-22
Sangre de Cristo ranges, rocks of..... 19
Sections, geologic, descriptions of..... 27-28
plate showing..... 12
Shumard, G. G., on Jornada del Muerto.... 35
Soledad Canyon, view of..... 18
Springs, occurrence of..... 31
Stanley, well water at, analysis of..... 36
Structure of region..... 25-32
Tertiary rocks, occurrence and character of..... 18-20, 24
Tonto formation, occurrence and character of..... 20
Topography of region..... 13-18
Trachite, occurrence of..... 25
Trinity sands, occurrence of..... 22
Unconformities, occurrence of..... 19
Vishnu quartzite, occurrence of..... 20
Volcanic cones, location of..... 14, 18, 28
Wallace, S. E., on Jornada del Muerto..... 10
Washita sands, occurrence of..... 22
Water, underground, analyses of..... 36
depth to..... 35, 38
extent of..... 34
horizons of..... 34-35, 38-39
occurrence of..... 11, 32-39
supply of, local obstructions to..... 38-39
Wells, classes of..... 37
sinking of..... 11, 37-38
water of, quality of..... 38

O

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[Water-Supply Paper No. 123.]

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Correspondence should be addressed to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

AUGUST, 1905.

Water-Supply and Irrigation Paper No. 124 Series P, Hydrographic Progress Reports, 29

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

BY

H. K. BARROWS and JOHN C. HOYT

PART I.—Atlantic Coast of New England Drainage

WASHINGTON

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CONTENTS.

	Page.
er of transmittal	7
oduction	9
peration and acknowledgments	18
John River drainage basin	20
Fish River at Wallagrass, Me	21
Aroostook River at Fort Fairfield, Me	23
Croix River drainage basin	26
St. Croix River at Spragues Falls, near Baring, Me	27
chias River drainage basin	31
Machias River near Whitneyville, Me	31
nobscot River drainage basin	34
Penobscot River at Millinocket, Me	36
Penobscot River at West Enfield, Me	37
Penobscot River (East Branch) at Grindstone, Me	40
Mattawamkeag River at Mattawamkeag, Me	44
Piscataquis River near Foxcroft, Me	47
Cold Stream at Enfield, Me	50
Phillips Lake and outlets in Dedham and Holden, Me	52
ennebec River drainage basin	55
Kennebec River at The Forks, Me	56
Kennebec River near North Anson, Me	59
Kennebec River at Waterville, Me	62
Moose River near Rockwood, Me	64
Roach River at Roach River, Me	65
Dead River near The Forks, Me	66
Carrabassett River at North Anson, Me	67
Sandy River near Madison, Me	71
Messalonskee River at Waterville, Me	72
Cobbosseecontee River at Gardiner, Me	73
ndroscoggin River drainage basin	74
Androscoggin River at Errol dam, N. H	75
Androscoggin River at Gorham, N. H	76
Androscoggin River at Shelburne, N. H	76
Androscoggin River at Rumford Falls, Me	78
Androscoggin River near Dixfield, Me	78
resumpscot River drainage basin	80
Presumpscot River at outlet of Sebago Lake, Me	80
co River drainage basin	81
Saco River near Center Conway, N. H	82

P

Merrimac River drainage basin
Merrimac River at Franklin Junction, N. H
Merrimac River at Garvins Falls, New Hampshire
Merrimac River at Lawrence, Mass
Pemigewasset River at Plymouth, N. H
Contoocook River at West Hopkinton, N. H
Suncook River at East Pembroke, N. H
Sudbury River at Framingham and Lake Cochituate at Cochituate, Mass
Nashua River (South Branch) at Clinton, Mass
Blackstone River drainage basin
Blackstone River at Woonsocket, R. I
Thames River drainage basin
Shetucket River near Willimantic, Conn
Connecticut River drainage basin
Connecticut River near Orford, N. H
Connecticut River at Sunderland, Mass
Connecticut River at Hartford, Conn
Israel River (above South Branch) near Jefferson Highlands, N. H
Israel River (below South Branch) near Jefferson Highlands, N. H
Ammonoosuc River at Bretton Woods, N. H
Zealand River near Twin Mountain, N. H
Little River near Twin Mountain, N. H
White River at Sharon, Vt
Ashuelot River at Winchester, N. H
Deerfield River at Deerfield, Mass
Ware River near Ware, Mass
Ware River at Gilbertville, Mass
Quabog River at West Warren, Mass
Swift River at West Ware, Mass
Westfield River at Russell, Mass
Housatonic River drainage basin
Housatonic River at Gaylordsville, Conn
Index

ILLUSTRATIONS.

	Page.
LATE I. Map showing location of principal gaging stations in the United States	10
II. Price current meters, with buzzers	12
IG. 1. Cable station, showing section of the river, car, gage, etc	11

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., March 16, 1905.

SIR: I transmit herewith the manuscript of Part I of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of Mississippi River.

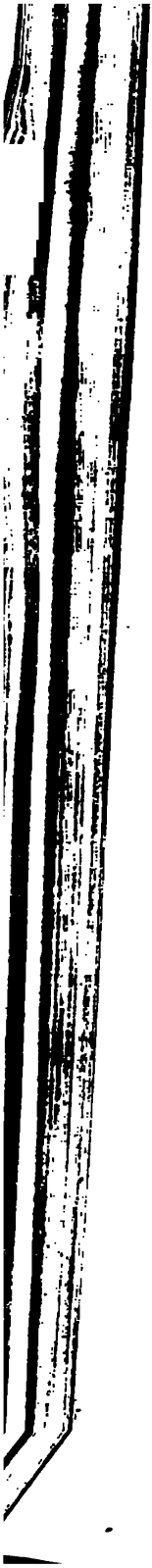
The larger part of the original data for this report was collected under the direction of district hydrographer H. K. Barrows, who was assisted by S. K. Clapp, F. E. Pressey, and T. W. Norcross. The assembling of the data and its preparation for publication were done under the direction of John C. Hoyt, who has been assisted by R. H. Bolster, Robert Follansbee, Willis E. Hall, A. H. Horton, and H. D. Padgett.

I request that this manuscript be published as one of the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.



PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART I.

By H. K. Barrows and John C. Hoyt.

INTRODUCTION.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. Since that date the work has been continually and gradually extended as larger funds became available. The first distinctive appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500, "for gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections." (Digest of Appropriations for 1895, p. 270.)

Since that time a similar act has been passed each year and the appropriations have gradually increased, as shown in the following table:

Annual appropriations for hydrographic surveys.

Year ending June 30, 1895	$12,500
Year ending June 30, 1896	20,000
Year ending June 30, 1897	50,000
Year ending June 30, 1898	50,000
Year ending June 30, 1899	50,000
Year ending June 30, 1900	50,000
Year ending June 30, 1901	100,000
Year ending June 30, 1902	100,000
Year ending June 30, 1903	200,000
Year ending June 30, 1904	200,000
Year ending June 30, 1905	200,000
Year ending June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions

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H. K. BARROWS and JOHN C. HOYT

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GOVERNMENT PRINTING OFFICE

1905

CONTENTS.

	Page.
ter of transmittal	7
roduction	9
operation and acknowledgments	18
John River drainage basin	20
Fish River at Wallagrass, Me	21
Aroostook River at Fort Fairfield, Me	23
Croix River drainage basin	26
St. Croix River at Spragues Falls, near Baring, Me	27
achias River drainage basin	31
Machias River near Whitneyville, Me	31
enobscot River drainage basin	34
Penobscot River at Millinocket, Me	36
Penobscot River at West Enfield, Me	37
Penobscot River (East Branch) at Grindstone, Me	40
Mattawamkeag River at Mattawamkeag, Me	44
Piscataquis River near Foxcroft, Me	47
Cold Stream at Enfield, Me	50
Phillips Lake and outlets in Dedham and Holden, Me	52
ennebec River drainage basin	55
Kennebec River at The Forks, Me	56
Kennebec River near North Anson, Me	59
Kennebec River at Waterville, Me	62
Moose River near Rockwood, Me	64
Roach River at Roach River, Me	65
Dead River near The Forks, Me	66
Carrabassett River at North Anson, Me	67
Sandy River near Madison, Me	71
Messalonskee River at Waterville, Me	72
Cobbosseecontee River at Gardiner, Me	73
ndroscoggin River drainage basin	74
Androscoggin River at Errol dam, N. H	75
Androscoggin River at Gorham, N. H	76
Androscoggin River at Shelburne, N. H	76
Androscoggin River at Rumford Falls, Me	78
Androscoggin River near Dixfield, Me	78
resumpscot River drainage basin	80
Presumpscot River at outlet of Sebago Lake, Me	80
aco River drainage basin	81
Saco River near Center Conway, N. H	82

Page.
Merrimac River drainage basin 85
Merrimac River at Franklin Junction, N. H 86
Merrimac River at Garvins Falls, New Hampshire 89
Merrimac River at Lawrence, Mass 89
Pemigewasset River at Plymouth, N. H 93
Contoocook River at West Hopkinton, N. H 101
Suncook River at East Pembroke, N. H 105
Sudbury River at Framingham and Lake Cochituate at Cochituate, Mass 105
Nashua River (South Branch) at Clinton, Mass 108
Blackstone River drainage basin 109
Blackstone River at Woonsocket, R. I 109
Thames River drainage basin 111
Shetucket River near Willimantic, Conn 112
Connecticut River drainage basin 113
Connecticut River near Orford, N. H 115
Connecticut River at Sunderland, Mass 120
Connecticut River at Hartford, Conn 121
Israel River (above South Branch) near Jefferson Highlands, N. H 123
Israel River (below South Branch) near Jefferson Highlands, N. H 125
Ammonoosuc River at Bretton Woods, N. H 128
Zealand River near Twin Mountain, N. H 131
Little River near Twin Mountain, N. H 134
White River at Sharon, Vt 136
Ashuelot River at Winchester, N. H 138
Deerfield River at Deerfield, Mass 140
Ware River near Ware, Mass 142
Ware River at Gilbertville, Mass 143
Quabog River at West Warren, Mass 144
Swift River at West Ware, Mass 144
Westfield River at Russell, Mass 145
Housatonic River drainage basin 147
Housatonic River at Gaylordsville, Conn 147
Index 153

ILLUSTRATIONS.

	Page.
PLATE I. Map showing location of principal gaging stations in the United States	10
II. Price current meters, with buzzers	12
FIG. 1. Cable station, showing section of the river, car, gage, etc	11

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., March 16, 1905.

R: I transmit herewith the manuscript of Part I of a series of ve papers which compose the Report of Progress of Stream Meas- nents for the Calendar Year 1904. Parts I to VI of this report ain the results of the data collected in the territory east of Missis- i River. Parts VII to XII are devoted to the data collected in the tory west of Mississippi River.

ie larger part of the original data for this report was collected r the direction of district hydrographer H. K. Barrows, who was ted by S. K. Clapp, F. E. Pressey, and T. W. Norcross. The nbling of the data and its preparation for publication were done r the direction of John C. Hoyt, who has been assisted by R. H. ter, Robert Follansbee, Willis E. Hall, A. H. Horton, and H. D. ;ett.

:equest that this manuscript be published as one of the series of er-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

on. CHARLES D. WALCOTT,
Director United States Geological Survey.

PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART I.

By H. K. Barrows and John C. Hoyt.

INTRODUCTION.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. Since that date the work has been continually and gradually extended as larger funds became available. The first distinctive appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500, "for gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections." (Digest of Appropriations for 1895, p. 270.)

Since that time a similar act has been passed each year and the appropriations have gradually increased, as shown in the following table:

Annual appropriations for hydrographic surveys.

Year ending June 30, 1895	$12,500
Year ending June 30, 1896	20,000
Year ending June 30, 1897	50,000
Year ending June 30, 1898	50,000
Year ending June 30, 1899	50,000
Year ending June 30, 1900	50,000
Year ending June 30, 1901	100,000
Year ending June 30, 1902	100,000
Year ending June 30, 1903	200,000
Year ending June 30, 1904	200,000
Year ending June 30, 1905	200,000
Year ending June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions

affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

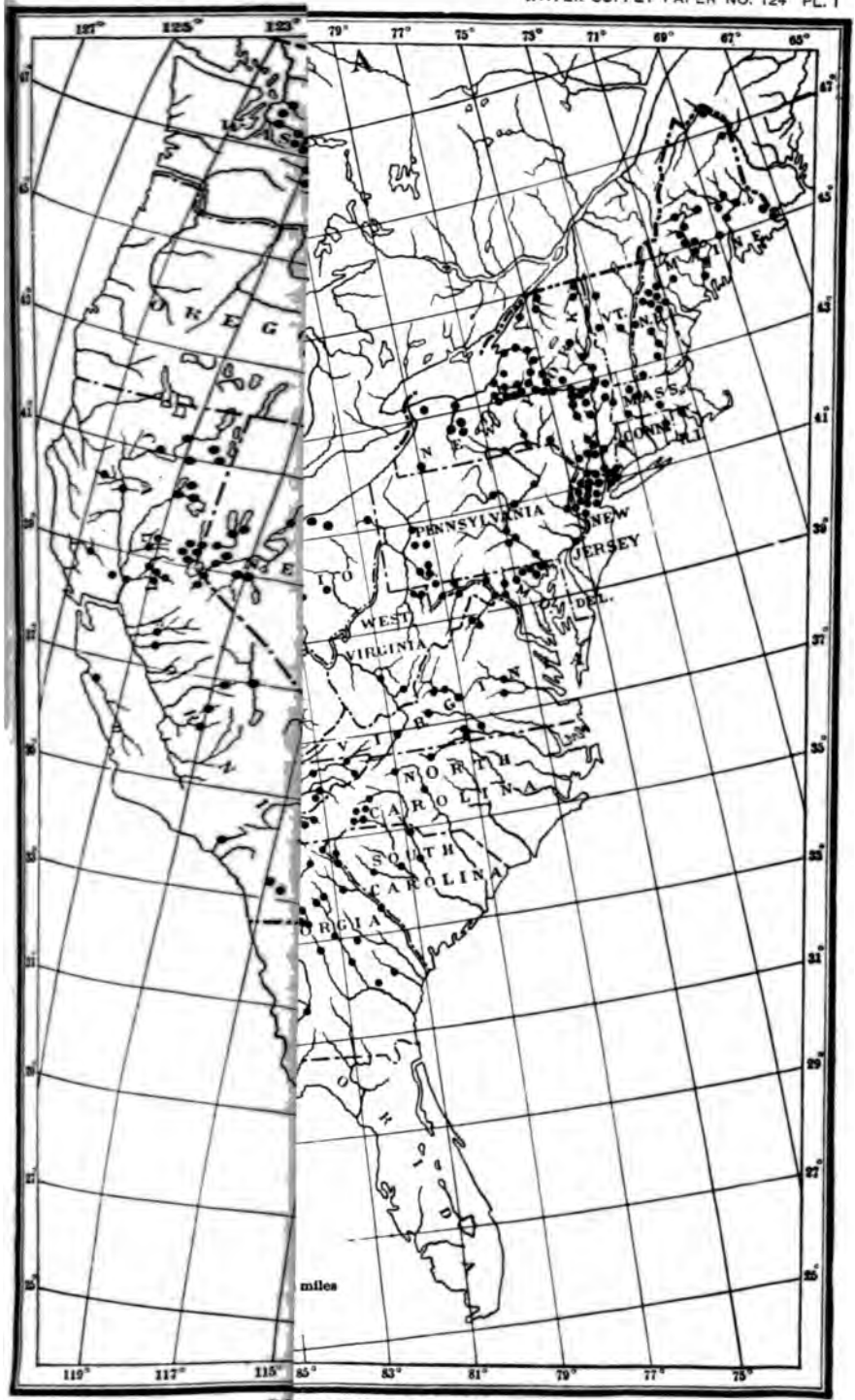
As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observations.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations; and second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag-line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is swift some appliance—generally a secondary cable—is necessary to hold the meter in position below the surface.



MAINED DURING 1904.

Gaging stations are generally located at bridges, if the channel contions are satisfactory, as from them the meter can be easily maniputed, and the cost of the equipment is comparatively small. The ations are located as far as possible at points where the channel is raight, both above and below the gaging section, and where there are ɔ cross currents, backwater, or boils. The bed of the stream should ɜ as clear as possible from large projections and of a permanent ıaracter. The banks should be high, and should overflow at high ages only. Great care is taken in the selection and equipment of aging stations, in order that the data may have the required degree f accuracy.

On many of the larger rivers where water power is developed by ams estimates of flow are obtained by observing the head on the crest ıd using a weir formula. On the smaller streams sharp-crested eirs are in some cases erected.

The principal instrument used in stream-measurement work is the ırrent meter, by which the velocity of the flow of water is determined.

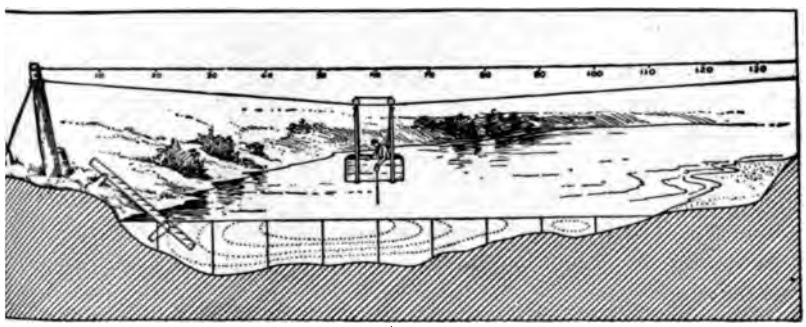


FIG. 1.—Cable station, showing section of river, car, gage, etc.

fter years of experience the Survey has adopted the Price current eter for general work. This meter, as is shown on Pl. II, is made two sizes, known as the large and small Price. The small Price has en largely developed by the officers of the Survey, using the Price oustic meter as a basis.

A discharge measurement is the determination of the quantity of ıter flowing past a certain point at a given time. This quantity is the oduct of two factors: (1) The mean velocity, which is the function the cross section, surface slope, wetted perimeter, and roughness of d; (2) the area, which depends upon the permanency of the bed and ɔ fluctuations of the surface, which govern the depth.

In making the measurement an arbitrary number of points are laid perpendicular to the thread of the stream (see fig. 1). These points ɔ usually at regular intervals, varying from 2 to 20 feet, depending on the size and conditions of the stream. They are known as measng points, and at them the observed data, the velocities and sound-

ings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity, or at an arbitrary depth, for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenth depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between 0.94 and 1.04, with a mean for the 910 observations of 1.00. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from 0.85 to 0.95, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements, or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity-curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth into the area bounded by this mean velocity-curve and the initial line. Owing to the length of time it takes to make these measurements, they are seldom used except for determining coefficients for purposes of comparison, and for measurements under ice.

PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

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PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

In the second multiple-point method the meter is held from 0.5 to 1 foot below the surface and about 0.5 foot above the bottom, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is not well adapted for general work, as the roughness of the bottom disturbs the velocity at that point. For shallow streams with comparatively smooth beds good results are obtained by this method. In the third multiple-point method the meter is held at mid depth, at 0.5 foot below the surface and at 0.5 foot above the bottom, and the mean velocity is determined by dividing the sum of the top velocity twice the mid-depth velocity, and the bottom velocity by 4.

The vertical integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface. The number of revolutions and the time taken in the operation is noted, and the mean velocity is found by dividing the number of revolutions by the number of seconds taken in the run. This method has the advantage in that the velocity at each point of the vertical is measured twice. It is well adapted for measurements under ice and as a check on the point methods.

The area, which is the other factor for determining the discharge of the stream, depends upon the stage of the river, which is taken on a gage, and the general contour of the bed of the stream, which is found by sounding. The soundings are usually taken at each measuring point at the time of the discharge measurement, either by using the meter and cable or by a special sounding line or rod. For stations with permanent beds standard cross sections are usually taken during low water. These sections serve to check the soundings which are taken at the time of the measurements, and from them any change which may have taken place in the bed of the stream can be detected. They are also used for obtaining the area for use in computations of high-water measurements, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at the various points of measurements the measuring section is divided into elementary strips, as shown in fig. 1, and the mean velocity, area, and discharge are determined separately for either a single or double strip. The total discharge and area are the sums of those for the various strips, and the mean velocity is obtained by dividing the total discharge by the total area.

The volume of water flowing in a stream is known as run-off. In expressing it various units are used, depending upon the kind of work for which the data are needed. Those used in this report are "second-feet," "acre-feet," "run-off per square mile," and "run-off in depth inches," and may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The "acre-foot" is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area, on the assumption that the run-off is uniformly distributed.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow per second.

The base data for computing the daily discharge of a stream are the daily gage heights and the various discharge measurements, of which there should be sufficient number to cover the range of stage. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights (2 and 3 depend on 1).

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent or practically permanent beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissas. Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. The mean velocity and area determined for each discharge measurement are also plotted. Through these points the curves of mea

locity and of area are drawn, and the rating curve is largely deter-
ned by taking the product of the mean velocity and the area at vari-
s stages as determined by these curves. These curves of mean
ocity and area are of special value in determining the location of
rating curve for stages at which actual discharge measurements are
t available and for extending the discharge curve outside the limits
the measurements. In the preparation of the rating table the dis-
rge for each tenth or half-tenth on the gage is found from the
ve. The first and second differences of these discharges are then
en and adjusted according to the law that they shall either be con-
nt or increasing, never decreasing. The discharges in the table are
n changed in accordance with these adjusted differences. In mak-
g up the station rating curve, the individual discharge measurements
l the conditions under which they were taken are carefully studied,
order that proper weight shall be given to each measurement.
ting curves in general take the form of a parabola, and as a rule the
gh-water portion of the curve approaches a straight line. For sta-
ns of permanent character, the results of the measurements from
ar to year should be within 5 per cent of the curve, with the excep-
n of those taken during high water, when the probable error may
as high as 10 per cent.

The determination of the daily discharge of streams with changeable
ds is difficult, and unless frequent discharge measurements are made,
e results obtained are only roughly approximate. For streams with
ntinually shifting beds, such as Colorado River and the Rio Grande,
charge measurements are made every two or three days, and the
charges for the intervening days are obtained by interpolation,
dified by the gage heights for these days. For stations with beds
ich shift slowly, or are only materially changed during floods, sta-
n rating curves and tables can be prepared for the periods between
anges, and satisfactory results can be obtained with two or three
asurements a month, providing measurements are taken soon after
e changes occur.

In determining the flow for periods when the streams are frozen,
ecial rating curves and tables have to be prepared from measure-
nts taken under these conditions. The methods of constructing
ese curves and tables are the same as for open sections. The dis-
arge measurements, however, are taken either by integration in ver-
als or by the vertical velocity-curve method, as sufficient experi-
nts have not been made on ice-covered streams to determine the laws
hich govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar
ear 1904, of which this is Part I, is published in a series of twelve
ater-Supply Papers, Nos. 124–135, inclusive, under the subtitles
llowing.

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha rivers, and Eastern Gulf of Mexico drainage.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meramec, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainage in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations and such other information that has been collected that has a direct bearing on these data, including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage heights gives for each day the mean height of the surface of the river as found from the mean of the gage readings taken on that day. At most of the stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated run-off the column headed "Maximum" gives the mean flow for the day when the mean gage height was the highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" gives the average flow for each second during the month. Upon this mean the computations for the three remaining columns which are defined on page 14 are based.

In the computations for the tables of this report the following general and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and money is imperative.

2. All items of computation should in general be expressed by at least two and by not more than four significant figures.

3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose per cent of error is 5 times the average per cent error of all the other measurements should be rejected.

4. In reducing the number of significant figures, or the number of decimal places, by dropping the last figure, the following rules apply:

(a) When the figure in the place to be rejected is less than 5, drop it without changing the preceding figure. Example: 1,827.4 becomes 1,827.

(b) When the figure in the place to be rejected is greater than 5, drop it and increase the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(c) When the figure in the place to be rejected is 5, and it is preceded by an even figure, drop the 5. Example: 1,828.5 becomes 1,828.

(d) When the figure in the place to be rejected is 5, and it is preceded by an odd figure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 1,828.

5. In constructing and applying rating tables a maximum limit of one-half per cent error should seldom be exceeded.

Special rules for computation.

1. Rating tables are to be constructed as close as the data upon which they are based will warrant. No decimals are to be used when the discharge is over 50 second-feet.

2. Daily discharges shall be applied directly to the gage heights as they are tabulated.

3. Monthly means are to be carried out to one decimal place when the quantities are below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the monthly mean shall be a significant figure. This also applies to the yearly mean.

4. Second-feet per square mile and depth in inches for the individual months shall be carried out at least to three significant figures, except in the case of decimals, where the first significant figure is preceded by one or more naughts (0), when the quantity shall be carried out to two significant figures. Example: 1.25; .125; .012; .0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following

Survey publications. A detailed index of these reports is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive.
West of Mississippi River, Water-Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at prices slightly above cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the names of the resident hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

Connecticut.—Resident hydrographer, N. C. Grover, until July 1, after that time H. K. Barrows,[a] assisted by S. K. Clapp and T. W. Norcross. Acknowledgment should be made to Edwin D. Graves, chief engineer of the Connecticut River bridge and highway district, for gage heights of Connecticut River near Hartford.

[a] The office of the resident hydrographer for New England, 6 Beacon street, Boston, Mass.

Maine.—Resident hydrographer, N. C. Grover, until July 1, after that time H. K. arrows; assisted by F. E. Pressey. Acknowledgments should be made to the angor and Aroostook Railroad and the Somerset Railroad for annual passes issued N. C. Grover (later to H. K. Barrows) and F. E. Pressey; to the Maine Central ailroad for annual pass, good between Portland and Vanceboro, issued to N. C. rover (later to F. E. Pressey), and to the Portland and Rumford Falls Railroad for ip passes issued when desired. Thanks are due to the following individuals and orporations for data furnished and assistance rendered: H. S. Ferguson, engineer r the Great Northern Paper Company, for furnishing data on flow of Penobscot iver at Millinocket; Dr. L. S. Chilcott, of Bangor, for gage readings of Phillips ake; Hollingsworth & Whitney Company, of Winslow, through James L. Dean, eir engineer, for records of flow of the Kennebec at Waterville; C. S. Humphreys, E., of Madison, for assistance in installing gage at Madison electric plant on Sandy iver, and the use of the plant for the purpose of procuring data on flow; the Chase Ianufacturing Company, at Waterville, for the use of their dam on Messalonskee iver for measurement purposes; Alex. H. Twombley, engineer for the Forest Paper ompany, of Yarmouthville, for records of flow of the Cobbossecontee; C. A. Mixer, ngineer for the Rumford Falls Power Company, for records of flow of Androscoggin iver at Rumford Falls; S. D. Warren & Co., of Westbrook, for records of flow of he Presumscot.

Massachusetts.—Resident hydrographer, N. C. Grover, until July 1; after that time, H. K. Barrows, assisted by S. K. Clapp and T. W. Norcross. Acknowledgments should be made to the Boston and Albany Railroad for pass, good between Boston and Pittsfield, issued to H. K. Barrows; R. A. Hale, principal assistant engineer of the Essex Company, Lawrence, for records of flow of Merrimac River at that point; Frederic P. Stearns, chief engineer of the Metropolitan Water and Sewerage Board, for records of flow of Sudbury and Nashua rivers and Lake Cochituate; X. H. Goodnough, chief engineer State Board of Health, for information regarding various streams in Massachusetts; the George H. Gilbert Manufacturing Company, of Ware, for assistance in procuring records of flow of Ware River at Gilbertville; the George H. Gilbert Manufacturing Company and the Otis Company, of Ware, for assistance in maintaining gaging station at Ware; John T. F. MacDonnell, of Holyoke, for the use of the dam at West Warren for measurement purposes; the West Warren Paper Company, through Dwight Holland, manager, for assisting in procuring data regarding flow of Swift River at West Ware.

New Hampshire.—Resident hydrographer, N. C. Grover, until July 1; after that time, H. K. Barrows, assisted by S. K. Clapp, F. E. Pressey, and T. W. Norcross. Acknowledgments should be made to the Maine Central and Boston and Maine Railroad for passes in New Hampshire, issued to N. C. Grover (later to H. K. Barrows) and S. K. Clapp; Walter H. Sawyer, agent of the Union Water Power Company, Lewiston, for assisting in procuring records of flow of Androscoggin River at Errol dam, and for other data concerning Androscoggin River; Hollis French, of French & Hubbard, Boston, for data regarding flow of the Merrimac at Garvins Falls and the use of this plant for measurement purposes; also to G. G. Shedd, resident engineer at this point, for assistance rendered. Measurements of Connecticut River at Orford were made in part by Prof. C. A. Holden, of Dartmouth College.

Rhode Island.—Resident hydrographer, N. C. Grover, until July 1; after that time, H. K. Barrows, assisted by S. K. Clapp and T. W. Norcross.

Vermont.—Resident hydrographer, N. C. Grover, until July 1; after that time, H. K. Barrows, assisted by S. K. Clapp and T. W. Norcross. Acknowledgments should be made to Profs. A. D. Butterfield and G. M. Brett, of the University of Vermont, for assistance rendered; to the Boston and Maine Railroad for passes issued to N. C. Grover (later to H. K. Barrows) and S. K. Clapp; to the Rutland Railroad for pass issued to H. K. Barrows, and to the St. Johnsbury and Lake Champlain Railroad for pass issued to H. K. Barrows.

ST. JOHN RIVER DRAINAGE BASIN.

St. John River drains the largest basin between St. Lawrence Rive on the north and Susquehanna River on the south. Its total drainag area is stated by Wells[a] to be 26,000 square miles, of which approxi mately 7,500 square miles lie in Maine, its basin occupying the whol northern portion of the State. The extreme headwaters lie in th mountainous region between Maine and Canada, at elevations of 1,50 and 2,000 feet; thence its waters flow at first generally northeasterl through Maine. From the point of junction of the northwest an southwest branches, where the river first takes its name, to its junc tion with St. Francis River, a distance of 90 miles, its course lie wholly in Maine, although a portion of the tributary area lies i Canada. In this distance Alleguash River is the only tributary o importance. Wells estimates the average slope in the 90 miles to b 1.6 feet per mile. From its junction with St. Francis River th St. John forms the northern boundary of Maine for 70 miles. Withi this distance the slope is slightly greater than above, having bee estimated to be 2.7 feet per mile, while the volume is considerabl augmented by two important tributaries—Fish River from the soutl and Madawaska River from the north. At the point where it leave the State line the river has an elevation of about 420 feet above se level and drains an area of 8,765 square miles, of which 4,670 squar miles are in Maine and 4,095 square miles in Canada. Beyond thi point it receives the waters of Aroostook and Meduxnekeag rivers the basins of which are almost entirely in Maine, besides severa smaller tributaries having their sources, and in some cases a larg portion of their drainage basins, in the same State.

The underlying rock is generally deep and either calcareous or cla slate. The basin is well forested; large areas have never been touche by the ax, while other portions have been lumbered for pine only Probably 85 to 90 per cent of the whole basin tributary to the river a the eastern boundary of Maine is in forest.

According to Wells, the ponds and lakes in this basin in Main aggregate a total surface area of 314 square miles. Of this water sur face 120 square miles, or 38 per cent, are tributary to Alleguash Rive (36 square miles of which have been diverted to Penobscot River); 6 square miles, or 19 per cent, are tributary to Aroostook River; an 80 square miles, or 25 per cent, are tributary to Fish River. A the outlets of several of these lakes dams have been built which stor water to be used in transporting logs.

Prior to 1845, a canal was cut from Telos Lake in the Alleguasl basin to Webster Lake in the Penobscot basin, and a dam was con structed between Chamberlain and Eagle lakes. Thus, by means o

[a] Wells, Walter, The water power of Maine, 1869.

these artificial structures, Chamberlain Lake, with its drainage basin of 270 square miles, was made tributary to the Penobscot. This diversion of St. John water is still continued. During the log-driving season, which varies considerably in its duration, nearly all of the run-off from this area is thrown to the Penobscot, while during the remainder of the year the gates in the dam at Chamberlain Lake are opened and water is allowed to flow both ways. On account of the fact that the gates in the dam at the outlet of Chamberlain Lake are about 2 feet lower than those in the dam at Telos Lake, the flow from this basin to the St. John is greater than that to the Penobscot when the gates in both are open. As the surface of the lake is lowered the proportion flowing to the St. John increases until at extreme low water none flows to the Penobscot.

Both the upper St. John and Allegash rivers are generally inaccessible. The middle portion, forming the northern boundary of the State, may be reached on the Canadian side at any point by the Temiscouata Railroad, or in Maine at Fort Kent and Van Buren by the Bangor and Aroostook Railroad, while the basins of Fish and Aroostook rivers are rendered easily accessible by means of the latter road. The drainage areas of the stream and its principal tributaries are as follows:

Drainage areas of St. John River and principal tributaries.

River.	Locality.	Area.
		Square miles.
St. John	Below Allegash	4,320
Do	Eastern boundary of Maine	8,765
St. Francis	Mouth	580
Madawaska	do	1,085
Tobique	do	1,705
Allegash	do	1,500
Fish	do	910
Do	Wallagrass	890
Aroostook	Mouth	2,350
Do	Fort Fairfield	2,230
Meduxnekeag	Mouth	520

No measurements of flow of St. John River have been published. The United States Geological Survey maintains gaging stations in this basin on Fish River at Wallagrass, Me., and on Aroostook River at Fort Fairfield, Me.

FISH RIVER AT WALLAGRASS, ME.

Fish River enters the St. John from the south at Fort Kent. It has a total drainage area of 910 square miles, all of which lies in Maine, and of which 80 square miles are water surface. The basin is very

generally wooded, probably 75 or 80 per cent of its area being still in forest. Of the several available power sites one only is partially developed and used for the manufacture of lumber. The underlying rock is shale or slate, and in general is well covered by soil.

The gaging station at Wallagrass was established by N. C. Grover on July 29, 1903. It is located just below the outlet of Wallagrass Brook. The area of the drainage basin at this point is 890 square miles. A standard chain gage is attached to trees on the bank; length of chain, 39.75 feet. It is referred to bench marks as follows: (1) Copper bolt in ledge 600 feet downstream from gage; elevation, 11.73. (2) Nail driven in blazed birch tree 5 feet upstream from gage; elevation, 11.91 feet. Elevations refer to datum of gage. The measurements of flow are made from a cable located about 1,500 feet downstream from the gage, or by wading at low stages of the river. The channel is straight 500 feet above and 300 feet below the cable, and is about 100 feet wide. The bed is permanent and of gravel. The depth increases gradually from either bank to a maximum at low water of 3.5 feet near the center. The current at the cable is generally strong. At extreme low water the observed mean velocity was 0.63 of a foot per second. The banks are high and are not liable to overflow. The gage is read once a day by Vital E. Michaud, of Wallagrass.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Fish River at Wallagrass, Me., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
September 18	F. E. Pressey	269	0.97	2.80	260
September 18	do	269	.97	2.80	261
October 20	do	53	2.80	2.40	148
October 20	do	208	.69	2.40	144
October 29	do	205	.63	2.13	129
October 29	do	33	3.30	2.06	109
November 12	do	241	.83	2.50	200
1904.					
May 5	F. E. Pressey	1,680	4.57	12.98	7,690
May 5	do	1,680	4.49	12.97	7,540
June 2	do	990	3.53	8.95	3,490
June 2	do	1,000	3.50	9.00	3,500
June 16	do	740	2.48	6.35	1,840
June 16	do	730	2.40	6.29	1,760
August 9	do	305	1.16	3.19	355
October 27	do	615	2.24	5.39	1,380

Mean daily gage height, in feet, of Fish River at Wallagrass, Me., for 1904.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	4.3	3.5	10.6	9.3	5.0	3.6	3.2	6.0	5.0	3.6
.....	.....	4.3	3.3	11.2	8.0	4.9	3.4	3.2	6.0	5.0	[a] 3.7
.....	.....	4.3	3.1	12.3	8.8	4.8	3.4	3.3	6.1	4.9	3.8
.....	.....	4.3	3.1	12.8	8.2	4.7	3.4	4.0	6.2	4.8	3.8
.....	.....	4.3	3.2	13.2	8.1	4.8	3.3	4.2	6.4	4.7	3.7
.....	.....	4.3	3.2	13.4	8.1	4.7	3.3	4.3	6.4	4.6	3.7
.....	.....	4.3	3.2	13.6	8.0	4.6	3.2	4.3	6.3	4.6	3.6
.....	.....	4.3	3.3	13.4	7.8	4.6	3.2	4.4	6.1	4.5	3.3
.....	.....	4.4	3.3	13.2	8.0	4.4	3.2	4.4	6.1	4.4	3.3
.....	.....	4.5	3.3	13.3	7.7	4.3	3.3	4.4	6.1	4.3	3.3
.....	.....	4.7	3.6	13.4	7.0	4.2	3.4	4.4	6.1	4.4	([b])
.....	.....	4.7	3.8	13.6	6.8	4.1	3.3	4.4	6.1	4.6	.....
.....	.....	4.7	4.0	13.6	6.7	4.2	3.2	4.5	6.1	4.5	.....
.....	4.2	4.7	4.2	13.4	6.6	4.5	3.3	4.6	6.0	4.3	.....
.....	4.2	4.7	4.3	12.7	6.4	4.4	3.2	4.6	5.9	4.3	[c] 5.2
.....	4.2	4.6	4.4	12.4	6.4	4.4	3.2	4.7	5.9	4.2	.....
.....	4.3	4.6	4.5	12.0	6.1	4.3	3.2	4.7	5.9	4.2	.....
.....	4.3	4.6	4.6	11.8	6.1	4.2	3.2	4.7	5.9	4.0	.....
.....	4.3	4.6	4.8	11.6	6.0	4.2	3.2	4.8	5.9	3.9	.....
.....	4.3	4.6	5.0	11.4	5.7	4.1	3.2	5.0	5.8	3.8	.....
.....	4.4	4.7	5.2	11.1	6.8	4.0	3.2	5.0	5.8	3.8	[d] 4.4
.....	4.5	4.8	5.4	10.9	6.0	3.9	3.2	5.0	5.8	3.7	.....
.....	4.5	4.8	5.6	10.6	5.2	3.9	3.3	5.0	5.6	3.7	.....
.....	4.3	4.8	5.9	10.4	5.3	3.9	3.3	5.1	5.6	3.7	.....
.....	4.3	4.8	6.5	10.1	5.1	3.8	3.4	5.2	5.5	3.7	.....
.....	4.3	4.7	7.2	10.0	4.9	3.8	3.4	5.2	5.5	3.7	.....
.....	4.3	4.5	7.6	9.9	5.0	3.7	3.3	5.2	5.4	3.7	.....
.....	4.3	4.3	8.0	9.6	5.3	3.7	3.3	5.2	5.3	3.6	.....
.....	4.3	4.2	9.1	10.1	5.3	3.8	3.3	5.2	5.3	3.6	.....
.....	.....	4.0	10.3	9.8	5.1	3.7	3.2	5.4	5.3	3.6	[e] 4.2
.....	.....	3.8	.....	9.2	.....	3.7	3.2	.....	5.0	.....	.....

[a] River frozen over. [b] Ice 0.5 foot thick.
[c] 1.2 foot thick. [d] Ice 1.6 foot thick. [e] Ice 1.9 foot thick.

—Gage readings through ice taken to surface of water in a hole cut in the ice.

AROOSTOOK RIVER AT FORT FAIRFIELD, ME.

oostook River enters the St. John from the west near Aroostook ion in the province of New Brunswick. It has a total drainage of 2,350 square miles, of which 2,320 square miles lie in Maine. ably 80 per cent of the whole basin is in forest. The underlying is usually slate. Lake storage is used for driving logs only. r power is used in Presque Isle. The principal falls on the river, n as Aroostook Falls, lie in Canada.

is gaging station was established by N. C. Grover on July 31, It is located at the steel highway bridge in the village of Fort eld. The drainage area at this point is 2,230 square miles. A ard chain gage is attached to the steel webbing of the upstream length of chain 27.61 feet. It is referred to bench marks as vs: (1) Northwest corner of south abutment, elevation 22.43 feet.

(2) Marked point on connection plate near gage, elevation 23.60 feet. Elevations refer to datum of gage. The initial point for soundings is on the right bank at the lower end of the inclined end post of the downstream truss. The channel is straight for at least 1,000 feet above and 1,000 feet below the station, and is about 350 feet wide, broken by three piers. The bed is of gravel and permanent. The banks are high and not liable to overflow. The current is medium at low water and swift at high water; the least observed mean velocity was 0.74 of a foot per second, at gage height 3.31 feet. The depths are small at low water, averaging about 2 feet. The gage is read twice daily by C. C. Harvey.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Aroostook River at Fort Fairfield, Me., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 13	N. C. Grover	547	1.44	3.70	785
September 10	do	363	.74	3.31	270
October 27	F. E. Pressey	406	.80	3.36	326
1904.					
May 3	F. E. Pressey	4,690	5.94	13.33	27,900
May 10	do	3,050	5.24	10.02	16,000
May 25	do	2,180	4.62	8.21	10,100
May 25	do	2,100	4.58	8.05	9,620
June 4	do	1,220	3.48	5.75	4,250
June 14	do	1,030	3.21	5.34	3,310
August 11	do	428	.97	3.44	415
October 25	do	950	2.66	4.96	2,530

Mean daily gage height, in feet, of Aroostook River at Fort Fairfield, Me., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1					12.80	6.90	5.50	3.95	3.50	6.35	4.90	3.90
2					13.60	6.50	5.20	3.85	3.55	6.95	4.80	4.20
3					13.25	6.15	5.35	3.80	3.60	6.85	4.70	4.30
4					12.55	5.80	5.65	3.70	3.95	6.45	4.60	4.30
5			[a] 5.00		12.35	6.15	5.70	3.70	5.55	6.10	4.55	4.20
6		[b] 4.10			12.75	6.30	5.60	3.70	6.05	5.85	4.50	4.10
7					12.55	6.65	5.10	3.60	5.75	5.65	4.50	4.30
8					11.90	6.80	4.80	3.60	5.30	5.50	4.35	4.35
9	5.10				11.30	6.70	4.60	3.60	5.10	5.35	4.30	4.30
10					10.70	6.25	4.35	3.60	4.85	5.30	4.25	4.30
11					10.10	5.90	4.25	3.60	4.55	5.30	4.20	4.45
12			[c] 5.20	10.50	9.90	5.80	4.05	3.55	4.40	5.40	4.05	4.55

[a] Ice 2.2 feet thick. [b] Ice 2.1 feet thick; gage height to top of ice=5.1 feet. [c] Ice 1.7 feet thick.

Mean daily gage height, in feet, of Aroostook River at Fort Fairfield, Me., for 1904—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
13		[a] 4.10			9.50	5.70	4.05	3.60	4.35	5.35	4.00	4.35
14					8.95	5.40	4.35	3.65	4.20	5.15	4.10	4.20
15					8.95	5.15	4.90	3.70	4.20	4.95	4.30	4.20
16	5.20			10.10	8.85	4.95	4.95	3.80	5.35	5.10	4.00	4.10
17					8.60	4.80	4.65	3.85	6.10	5.05	3.95	[b] 4.10
18						4.65	4.50	3.80	5.95	4.95	4.10	
19			[c] 5.00	7.80		4.45	4.25	3.80	5.85	4.90	3.75	
20		[d] 4.10				4.45	4.20	3.85	5.80	4.85	3.75	
21						4.30	4.00	3.80	5.80	4.80	3.95	
22						4.15	4.00	3.90	5.65	4.80	4.05	
23	[e] 4.90					4.00	3.90	3.95	5.45	4.80	4.10	
24						3.95	3.75	3.90	5.25	4.95	3.90	[f] 4.10
25						4.10	3.70	3.85	5.20	5.05	3.90	
26						4.30	3.70	3.80	5.55	5.00	3.85	
27		[c] 5.00				5.95	3.75	3.65	5.80	5.00	3.90	
28						6.25	3.75	3.55	5.75	5.10	3.90	
29						5.75	3.75	3.50	5.55	5.15	4.20	
30	[a] 4.60			13.35		5.35	3.85	3.50	5.50	5.05	3.95	
31							3.90	3.50		5.00		[g] 4.10

[a] Ice 2 feet thick; gage height to top of ice=5 feet.
[b] Ice .2 foot thick.
[c] Ice 2.1 feet thick.
[d] Ice 2.2 feet thick; gage height to top of ice=5 feet.
[e] Ice 1.5 feet thick.
[f] Ice .8 foot thick.
[g] Ice 1.1 feet thick.

NOTE.—During frozen season gage readings are to surface of water in hole cut in ice. Ice floats normally on water except as noted.

Rating table for Aroostook River at Fort Fairfield, Me., from August 1, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.00	48	3.95	1,022	5.70	4,005	8.00	9,500
3.05	79	4.00	1,087	5.80	4,215	8.20	10,100
3.10	112	4.10	1,220	5.90	4,425	8.40	10,710
3.15	147	4.20	1,360	6.00	4,635	8.60	11,330
3.20	185	4.30	1,500	6.10	4,845	8.80	11,960
3.25	226	4.40	1,645	6.20	5,060	9.00	12,600
3.30	270	4.50	1,795	6.30	5,275	9.20	13,240
3.35	317	4.60	1,950	6.40	5,495	9.40	13,900
3.40	368	4.70	2,110	6.50	5,715	9.60	14,560
3.45	422	4.80	2,275	6.60	5,940	9.80	15,230
3.50	478	4.90	2,445	6.70	6,165	10.00	15,910
3.55	535	5.00	2,620	6.80	6,395	10.50	17,650
3.60	593	5.10	2,805	6.90	6,630	11.00	19,400
3.65	652	5.20	2,995	7.00	6,865	11.50	21,200
3.70	712	5.30	3,190	7.20	7,345	12.00	23,000
3.75	772	5.40	3,390	7.40	7,840	12.50	24,850
3.80	833	5.50	3,595	7.60	8,360	13.00	26,700
3.85	895	5.60	3,800	7.80	8,910	13.50	28,600
3.90	958						

The foregoing table is applicable only for open-channel conditions. It is based upon 11 discharge measurements made during 1903 and 1904. It is well defined between gage heights 3.30 feet and 13.30 feet. The table has been extended beyond these limits. Below gage height 3.3 feet the curve is very uncertain.

Estimated monthly discharge of Aroostook River at Fort Fairfield, Me., for 1903 and 1904.

[Drainage area, 2,230 square miles.]

Month.	Discharge in second-feet.			Run off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
August	1,290	368	641	0.287	0.331
September	1,087	226	473	.212	.236
October	422	79	217	.097	.112
November	2,110	270	910	.408	.455
December 1-14	1,645	317	1,100	.326	.170
1904.					
May 1-17	28,980	11,330	19,920	8.93	5.65
June	6,630	1,022	3,648	1.64	1.83
July	4,005	712	1,825	.818	.943
August	1,022	478	734	.329	.379
September	4,845	478	2,985	1.34	1.49
October	6,748	2,275	3,352	1.50	1.73
November	2,445	772	1,348	.604	.674
December 1-17	1,872	958	1,429	.641	.405

ST. CROIX RIVER DRAINAGE BASIN.

St. Croix River is formed by two branches; one, known as the upper St. Croix or Chiputneticook River, is the outlet of Schoodic Lakes; the other, Kennebasis River, is the outlet of the western lakes of the area, known as Kennebasis Lakes. The upper St. Croix, with its tributary lakes, forms nearly half of the eastern boundary of Maine, separating that State from New Brunswick. The total drainage area of the main stream is about 1,630 square miles, of which 920 square miles are tributary to the great reservoir systems controlled by dams at Vanceboro and Princeton. The length of the stream from the headwaters to the mouth is 100 miles. The basin is, in general, lower than that of any of the larger streams of the State flowing into the Atlantic, its headwaters having an elevation of about 540 feet. The fall from Chiputneticook (the lower of the Schoodic Lakes) to tide water, a distance of 54 miles, is, however, 382 feet, or 7 feet to the mile. At a number of places where falls and rapids occur water power has been or can easily be developed.

The lake surface of the upper St. Croix is approximately 50 square miles, and that of the West Branch 70 square miles in area, taking into account only the principal lakes and ponds. Indeed, above Vanceboro and Princeton, each branch of the river is simply a succession of lakes to almost the extreme headwaters. Wells estimated the total lake surface of the St. Croix as not less than 150 square miles, or nearly one-tenth of the total basin. The drainage area at various points on the river is given in the following table:

Drainage area of St. Croix River.

	Sq. miles.
Main river:	
Vanceboro dam, foot of the Schoodic Lakes	420
Little Falls	500
Immediately above mouth of West Branch	690
Immediately below mouth of West Branch	1,360
Spragues Falls	1,390
Calais, lower dam	1,530
Mouth of river, eastern border of town of Calais	1,630
West Branch:	
Princeton dam	500
Confluence with main river	670

A large proportion of the drainage basin is still covered with timber, and above Vanceboro and Princeton the region is for the most part wild and inaccessible. The greater part of the timber land in this region is controlled by sawmill owners at Calais and St. Stephen. In 1898 the amount of lumber sawed annually had decreased from about 100 million feet to 25 million feet, and since then the number of sawmills has been greatly reduced. In 1901 the lumber sawed amounted to 28 million feet, showing that the rate of cutting has remained nearly constant during the last few years. There are on this stream favorable locations for paper and pulp mills, but arrangements would have to be made with the sawmill owners in order to obtain a supply of timber.

The river is navigable as far as Calais, except during two months of the year, when it is frozen. Calais has railroad connection with Bangor directly over the Washington County Railroad, and, by way of Vanceboro, over the Canadian Pacific and the Maine Central railroads. There is also a short road connecting Princeton with Calais. Above Princeton the transportation facilities are poor.

ST. CROIX RIVER AT SPRAGUES FALLS, NEAR BARING, ME.

This station was established December 4, 1902, by F. E. Pressey. The drainage area at this point is 1,390 square miles. A standard chain gage is attached to the lower guard timber of the Washington County Railroad bridge; length of chain, 24.84 feet. It is referred to bench marks as follows: (1) The downstream corner of bridge seat on

right abutment; elevation, 17.60 feet. (2) Copper bolt in bowlder on right bank about 200 feet downstream from the bridge; elevation, 15.98 feet. Elevations refer to the datum of the gage.

The measurements of flow are made from a car suspended on a steel cable stretched over the river about one-half mile above the bridge. The initial point for soundings is 60 feet from small pine tree near anchorage on right bank. The channel is straight for 100 feet above and 1,000 feet below the cable, and has an unbroken width of about 200 feet at ordinary stages. The banks are high and rocky, and the bed is rocky and permanent. The observed mean velocity at the cable has varied between 5.49 feet per second at gage height 9.70 feet and 1.29 feet per second at gage height 6.53 feet. The measurement at gage height 6.11 feet was made from the bridge to which the gage is attached; mean velocity, 1.41 feet per second. The gage is read twice daily by Simeon Phinney, section foreman on the Washington County Railroad, who resides in Baring, Me.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of St. Croix River at Spragues Falls, near Baring, Me., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 21	R. M. Connor	1,070	5.50	9.70	5,880
April 20	do	984	5.15	9.30	5,060
April 28	do	751	3.59	8.30	2,700
April 29	do	778	3.84	8.40	2,990
May 18	do	628	2.30	7.20	1,45[illegible]
May 19	do	658	2.34	7.30	1,54[illegible]
September 9	F. E. Pressey	609	1.29	6.53	7[illegible]
September 9 [a]	do	609	1.31	6.55	7[illegible]
October 1	N. C. Grover	418	1.41	6.11	5[illegible]
1904.					
April 27	F. E. Pressey	990	4.89	9.27	4,[illegible]
August 23 [a]	do	570	2.39	7.10	1,[illegible]

[a] Made at bridge.

laily gage height, in feet, of St. Croix River at Spragues Falls, near Baring, Me., for 1904.

ıy.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	8.0	[a]8.0	8.2	[b]8.0	.....	8.4	8.1	8.0	6.9	7.4	7.3	6.8
.....	8.0	8.0	8.2	8.0	11.0	8.4	8.1	7.9	6.9	.....	7.2	6.8
.....	8.1	8.0	8.2	.....	10.9	8.3	.....	7.7	6.9	7.3	7.0	6.8
.... .	8.3	8.0	8.2	8.1	10.0	8.3	8.0	7.6	.....	7.2	7.0	.....
.....	8.3	8.0	8.2	8.1	10.0	.....	8.0	7.5	7.0	7.1	6.9	6.9
.....	8.3	8.0	.....	8.3	9.8	8.4	7.9	7.5	7.0	7.0	.....	7.2
.....	8.3	.....	8.2	8.6	9.7	8.4	7.8	.....	7.0	6.9	6.9	7.3
.....	8.3	7.8	[c]8.5	8.8	.....	8.4	8.3	7.3	6.9	6.9	6.9	7.4
.....	.....	7.8	8.5	9.4	8.5	8.4	8.3	7.2	6.8	.....	6.9	7.4
.....	.....	7.7	8.5	.....	8.6	8.4	.....	7.2	6.8	6.7	6.9	7.4
.....	.....	7.7	8.5	12.4	8.7	8.4	8.5	7.2	.....	6.7	6.8	.....
.....	8.0	[d]7.7	8.5	12.4	10.1	.....	8.6	7.2	6.7	6.7	6.8	7.9
.....	8.0	7.7	.....	12.0	11.7	8.1	8.8	7.2	6.7	6.7	.....	7.9
.....	8.0	.....	8.6	11.4	11.9	8.1	8.8	.....	6.7	7.0	6.8	7.9
.....	8.0	7.8	8.6	10.9	.....	7.9	8.9	7.2	7.0	7.1	6.8	7.7
.....	8.0	7.8	8.6	10.5	11.2	7.9	8.9	7.1	7.1	.....	6.8	7.5
.....	7.9	7.8	8.6	.....	10.5	7.9	.....	7.1	7.1	7.0	6.7	7.5
.....	7.8	[e]7.8	8.6	9.4	10.5	7.9	8.6	7.1	.....	7.0	6.6	.....
.....	7.7	7.8	8.6	9.4	10.4	.....	8.6	7.1	7.0	7.0	6.6	7.2
.....	7.7	7.8	.....	9.6	10.2	7.8	8.6	7.1	6.9	7.0	.....	7.0
.....	7.8	.....	8.5	9.4	10.1	7.8	8.6	.....	6.8	6.9	6.7	6.7
.....	7.9	[f]8.0	8.5	9.4	.....	8.2	8.6	7.2	6.8	6.9	6.8	7.0
.....	7.9	8.0	8.4	9.4	9.9	8.2	8.6	7.2	6.8	.....	6.8	7.0
.....	.....	8.0	8.4	.....	9.8	8.2	.....	7.1	6.8	7.8	6.9	7.0
.....	8.0	8.1	8.4	9.3	9.8	8.2	8.6	7.1	.....	7.7	7.0	.....
.....	8.0	8.1	8.4	9.3	9.6	.....	8.6	7.1	7.1	7.5	7.1	6.9
.....	[g]8.0	8.1	8.4	9.3	9.6	8.1	8.7	7.1	7.1	7.4	.....	6.9
.....	8.0	.....	8.4	9.3	9.5	8.1	8.7	.....	7.0	7.4	7.0	6.9
.....	8.0	8.1	8.0	9.3	.....	8.1	8.7	7.0	7.0	7.4	6.9	6.8
.....	8.0	.....	8.0	9.4	8.9	8.1	8.7	6.9	7.0	.....	6.8	6.8
.....	.....	.....	8.0	.....	8.7	.....	.....	6.9	.....	7.3	.....	6.8

[a] Ice 0.85 foot thick.
[b] River clear of ice.
[c] Ice 1 foot thick.
[d] Ice 1.1 feet thick.
[e] Ice 1.25 feet thick.
[f] Thaw; water running on top of ice.
[g] Water and ice same height; ice 0.4 foot thick; river froze about Jan. 19.

:—During frozen season gage readings are to surface of water in hole cut in ice.

Rating table for St. Croix River at Spragues Falls, near Baring, Me., from December 4, 1902, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
5.9	525	7.1	1,330	8.3	2,775	9.5	5,450
6.0	655	7.2	1,440	8.4	2,920	9.6	5,750
6.1	585	7.3	1,550	8.5	3,075	9.7	6,055
6.2	620	7.4	1,660	8.6	3,245	9.8	6,360
6.3	660	7.5	1,775	8.7	3,430	10.0	6,970
6.4	710	7.6	1,890	8.8	3,635	10.2	7,580
6.5	770	7.7	2,010	8.9	3,855	10.4	8,190
6.6	840	7.8	2,130	9.0	4,090	10.6	8,800
6.7	925	7.9	2,255	9.1	4,340	10.8	9,410
6.8	1,020	8.0	2,380	9.2	4,605	11.0	10,020
6.9	1,120	8.1	2,510	9.3	4,880	11.5	11,545
7.0	1,225	8.2	2,640	9.4	5,160		

The above table is applicable only for open-channel conditions. It is based upon 11 discharge measurements made during 1903 and 1904. It is well defined between gage heights 6.10 feet and 9.50 feet. The table has been extended beyond these limits. Above gage height 9.60 the rating curve is a tangent, the difference being 305 per tenth.

Estimated monthly discharge of St. Croix River at Spragues Falls, near Baring, Me., for 1904.[a]

[Drainage area, 1,390 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April	14,290	2,380	6,027	4.34	4.84
May	12,760	3,075	7,026	5.05	5.82
June	2,920	2,130	2,605	1.87	2.09
July	3,855	2,130	3,089	2.22	2.56
August	2,380	1,120	1,495	1.08	1.24
September	1,330	925	1,140	.820	.915
October	2,130	925	1,368	.984	1.13
November	1,550	840	1,102	.793	.885
December	2,255	925	1,418	1.02	1.18

[a] Sunday discharges interpolated.

MACHIAS RIVER DRAINAGE BASIN.

Machias may be taken as fairly representative of several of the streams of Maine which empty their waters directly into the and which are commonly referred to as "coastal rivers." Its ainage basin is 495 square miles, nearly all of which lies in gton County, Me. Its extreme headwaters lie at an elevation ly 500 feet, and are not more than 50 miles from tide water. isted 20 lakes in this basin, aggregating 29.5 square miles in water surface. Without important exception these lie, how- the extreme headwaters. Dams are maintained at several of ets of the lakes, and the stored water is used for log driving. nderlying rock is usually granite. Probably 70 to 80 per cent asin is still in forest.

MACHIAS RIVER NEAR WHITNEYVILLE, ME.

gaging station was established October 17, 1903, by F. E. , at the bridge of the Washington County Railroad, near yville. The drainage area at this point is 465 square miles. ard chain gage is attached to the guard timber on the down- side of the bridge; length of chain, 25.34 feet. It is referred ollowing-described bench marks: (1) Copper bolt in outcrop- dge on upstream side of railroad track and 170 feet from the left abutment; elevation, 20.12 feet. (2) Downstream outer of bridge seat of right abutment; elevation, 18.05 feet. (3) point on floor beam of bridge at zero end of gage; elevation, et. Elevations refer to datum of the gage. The initial point ndings is on the left bank at the lower end of the inclined end the downstream truss. The velocity is small at low water. neasurements may be made by wading at a point 200 feet above lge at low stages of the river. The water is confined to one at the bridge at all stages; the width is about 130 feet.

rt distance above the station is a dam which stores water for he mills in Machias. The gates in this dam are opened and ach day during low stages of the river. As a result the river s as much as 0.5 of a foot on the gage. The bed is sandy, but nt. The gage is read twice daily by George McKenzie, a f Whitneyville.

bservations at this station during 1904 have been made under tion of H. K. Barrows, district hydrographer.

Discharge measurements of Machias River near Whitneyville, Me., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet*
1903.					
October 17	F. E. Pressey	647	0.34	6.63	2
1904.					
April 26	F. E. Pressey	1,030	1.92	9.67	1,9
April 28	do	1,230	2.42	11.19	2,9
May 17	do	1,250	2.94	11.64	3,6
May 20	do	1,360	3.16	12.41	4,3
May 20	do	1,360	3.07	12.38	4,1
May 21	do	1,320	2.88	12.07	3,8
August 22	do	860	1.28	8.54	1,1
August 24	do	730	.74	7.51	[illegible]
November 7	do	580	.56	6.40	[illegible]

Mean daily gage height, in feet, of Machias River near Whitneyville, Me., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	De
1	7.3	7.9	7.8	9.3	12.4	10.0	7.5	6.0	6.0	7.9	6.2	
2	7.2	7.8	7.8	9.4	11.9	10.0	7.6	5.7	5.8	8.1	6.2	
3	7.2	[b]7.7	[c]8.0	9.9	11.2	10.0	7.8	5.4	6.0	7.6	6.0	
4	7.1	7.7	8.8	9.6	10.1	10.0	7.8	5.2	5.8	7.2	6.4	
5	7.2	7.6	9.4	9.4	9.2	10.0	7.2	5.4	6.2	7.0	6.5	
6	[d]7.2	7.6	9.5	9.6	8.8	9.4	7.0	5.4	6.8	6.8	6.4	
7	7.2	7.7	9.3	10.0	8.3	9.7	6.9	5.6	5.6	6.8	6.5	
8	7.2	7.6	10.4	10.4	8.2	10.3	6.9	6.0	6.7	6.8	6.4	
9	7.2	8.0	12.2	11.4	7.9	9.6	6.8	5.9	6.5	6.9	6.0	
10	7.2	7.6	11.8	12.8	9.2	8.8	7.6	5.2	6.3	6.8	6.2	
11	7.2	[e]7.7	11.0	14.0	10.9	8.2	7.3	5.4	5.0	6.6	6.4	
12	7.3	7.8	10.5	13.3	13.9	8.1	6.8	5.7	5.0	6.1	6.2	
13	7.3	7.7	10.4	12.8	15.6	7.9	7.0	5.8	5.6	6.8	6.6	
14	7.6	7.7	9.6	12.4	14.0	7.6	7.2	5.9	6.2	7.6	7.0	[f]
15	7.7	7.6	9.2	11.6	11.4	7.6	7.2	6.1	7.9	7.0	7.4	
16	7.7	7.6	9.0	10.6	10.6	7.5	7.0	6.0	10.8	7.1	7.4	
17	7.7	7.5	8.7	10.1	11.9	7.4	7.4	5.8	9.4	7.0	6.6	[g]
18	7.6	[h]7.4	8.2	9.8	12.9	7.2	7.2	6.2	8.2	6.6	7.0	
19	7.6	7.3	8.0	9.7	13.0	7.4	6.3	6.2	7.5	6.4	6.4	
20	7.6	7.2	8.0	9.8	12.4	7.2	6.3	5.7	6.9	6.1	6.4	
21	7.6	7.2	8.2	9.5	12.0	7.2	6.3	8.1	6.7	6.4	6.4	
22	7.6	7.4	8.1	[j]9.2	11.7	7.2	6.0	8.6	6.6	8.0	6.4	[k]
23	7.5	8.0	8.3	9.2	11.4	7.2	5.9	8.0	6.6	9.3	6.7	
24	7.5	8.4	8.8	9.3	10.6	7.2	6.6	7.5	6.4	8.5	6.8	
25	7.5	[l]8.6	9.2	9.3	9.6	7.2	6.6	7.0	7.2	7.6	7.3	
26	7.5	8.6	9.7	9.6	9.4	7.3	6.2	6.2	8.0	7.2	7.4	
27	7.6	8.4	11.0	10.6	9.2	7.2	6.2	5.2	7.8	7.2	7.0	
28	7.5	8.2	11.0	11.2	9.5	7.0	6.0	5.8	7.0	7.0	6.6	
29	7.7	7.9	10.4	11.4	9.8	6.8	5.8	5.8	7.0	6.8	6.2	
30	7.7	.....	9.7	12.4	9.9	6.8	5.7	6.2	7.1	6.8	6.3	
31	7.8	.....	9.3	.....	9.9	.....	6.0	6.2	.....	6.5	.....	[m]

[a] Ice January 1 to March 21 and December 9–31. No estimate.
[b] Ice 1.35 feet thick.
[c] Ice 1.25 feet thick.
[d] Ice 0.65 foot thick.
[e] Ice 1.5 feet thick.
[f] Gage reading to surface of ice=6.3; ice 0.7 foot thick.
[g] Gage reading is to surface of ice; ice 0.8 foot thick.
[h] Ice 1.65 feet thick.
[i] Ice 0.8 foot thick.
[j] River clear of ice.
[k] Gage reading is to surface of ice; ice 1.0 [illegible] thick.
[l] Ice 1.4 feet thick.
[m] Gage reading is to surface of ice; ice 1.1 [illegible] thick.

NOTE.—Unless otherwise noted, gage heights during frozen season are to surface of water in cut in ice.

Rating table for Machias River near Whitneyville, Me., from October 17, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.6	258	7.4	500	8.4	1,000	10.0	2,130
6.7	283	7.5	542	8.6	1,120	10.5	2,545
6.8	309	7.6	587	8.8	1,250	11.0	2,980
6.9	336	7.7	634	9.0	1,380	11.5	3,430
7.0	365	7.8	682	9.2	1,520	12.0	3,900
7.1	395	7.9	730	9.4	1,660	12.5	4,375
7.2	427	8.0	780	9.6	1,810	13.0	4,860
7.3	462	8.2	890	9.8	1,970		

The above table is applicable only for open-channel conditions. It is based upon 11 discharge measurements made during 1903 and 1904. It is well defined between gage heights 7.5 feet and 12.5 feet. The table has been extended beyond these limits, and is very uncertain below 7 feet.

Estimated monthly discharge of Machias River near Whitneyville, Me., for 1903 and 1904.

[Drainage area, 465 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
October 18–31	1,060	258	562	1.21	.630
November	1,185	336	652	1.40	1.56
December	1,217	445	703	1.51	1.74
1904.					
March 22–31	2,980	835	1,834	3.94	1.47
April	5,860	1,520	2,681	5.77	6.44
May	7,570	730	2,979	6.41	7.39
June	2,375	309	989	2.13	2.38
July	682	104	334	.718	.828
August	1,120	54	216	.465	.536
September	2,800	41	438	.942	1.05
October	1,590	159	448	.963	1.11
November	500	144	265	.570	.636
December 1–8	213	71	142	.305	.091

PENOBSCOT RIVER DRAINAGE BASIN.

This basin, which has a total area of about 8,500 square miles, wholly in Maine. It extends from the Atlantic Ocean on the soutl the basin of the St. John on the north, a distance of 160 miles; from the New Brunswick boundary on the east to the Quebec bound on the west, a distance of 115 miles. The general elevation of basin is lower than that of the drainage basins to the west. The h waters of the main river lie in the mountainous region on the bound of Quebec at an elevation of nearly 2,000 feet. The slopes of upper tributaries are generally steep. Chesuncook Lake lies near center of the basin at an elevation of 930 feet. From this poin tidewater, the distance along the river is about 121 miles, indica an average slope of 7.7 feet to the mile. This is concentrated at in vals by ledges where water power has been or may be developed. water from some 800 square miles of the basin is discharged into main river below its lowest available water power at Bangor.

Taken as a whole, the basin is rather uniform in its topogra features. Hills and low mountains stretch from near the sea to al Bangor; farther north is an undulating plain, while to the west surface becomes more broken and is greatly diversified by h detached peaks, lakes, ponds, and swamps. At the south the b merges into that of the Kennebec, and at the north into that of Alleguash, terminating on the northwest, at the boundaries of State, in a region of highland intermingled with swamps and lago The whole northern basin of the main river and its tributaries i forest. Original growth covers a large portion of this area, an general, wherever cuttings have been made, a dense second gro has sprung up. Extensive areas in the southern basin have l cleared and converted into farms. Probably 70 to 80 per cent of whole basin above Bangor is in forest. Throughout the upper por of the basin slate is the principal outcropping rock, being succe to the east and south by schists, gneiss, and granite. The soil is ma clay, gravel, and loam.

The drainage area of the river and its chief tributaries are give the following table.

Drainage areas of Penobscot River and principal tributaries. [a]

River.	Locality.	Drainage area.
		Square miles.
.....	Opposite northwest extremity of Moosehead Lake, township of Seboomook, immediately below mouth of Nulhedus Creek.	510
.....	Entrance into Chesuncook Lake.....	850
.....	Outlet of Chesuncook Lake	1,450
.....	Millinocket, outlet of Twin Lakes	1,880
.....	Immediately below mouth of East Branch of Penobscot. [a]	3,260
.....	Immediately below mouth of Mattawamkeag. [a]	4,940
.....	West Enfield, immediately below mouth of Piscataquis. [a]	6,630
.....	Sunk Haze Rips [a]	7,260
.....	Old Town, above mouth of Pushaw River [a] ..	7,340
.....	Bangor, above mouth of Kenduskeag River [a].	7,720
.....	Mouth [a]	8,550
gomoc.....	Entrance into Chesuncook Lake.....	230
h of Penobscot	Grindstone [a]	1,130
.....	Mouth [a]	1,160
keag	Immediately below outlet of Baskahegan Lake.	190
.....	Mouth	1,510
.....	Low's bridge.....	280
.....	Dover	330
.....	Mouth	1,500
teag	.....do	400
m	.....do	37
.....	Enfield post-office.....	26
ake outlets:		
ern outlet at tion with.	Phillips Lake	11.5
ern outlet.....	East Holden	12.3
ake area.....	.....	1.4

Chamberlain Lake basin (270 square miles). See description of St. John River drainage

The United States Geological Survey now maintains gaging stations at the following places in the Penobscot basin: On the Penobscot at West Enfield; East Branch of the Penobscot at Grindstone; Mattawamkeag at Mattawamkeag; Piscataquis near Foxcroft; Cold Stream at Enfield; Phillips Lake and its outlets in Holden and Dedham.

The discharge of the Penobscot is also obtained at Millinocket from data furnished by private parties.

PENOBSCOT RIVER AT MILLINOCKET, ME.

The discharge of Penobscot River at Millinocket has been com puted and the data furnished by H. S. Ferguson, engineer for th Great Northern Paper Company. These results were obtained b considering the flow through the wheels, the flow over the dam, an such quantities of water as are used from time to time by the l sluice, filters, etc. The wheels were rated at Holyoke, Mass., befo being placed in position. As the head under which they work, ave aging about 110 feet, is much greater than the head under which th were tested, numerous tube float measurements of flow in the can leading to the mill have been made by Mr. Ferguson, in order determine just how much water the mill used under different con tions of gate openings. In addition to this, during 1904 a series current-meter measurements were made by the United States Geolo cal Survey to check results as obtained by the floats, and to enabl suitable coefficient to be obtained for use with the float measuremen It is believed by means of these various checks upon the measuremen that a very good estimate has been made for the flow through t wheels. The dam, known as Quakish Lake dam, is of concrete, re ing on rock, and does not leak. The flow over it was computed use of the formula, $Q=c\ b\ H^{\frac{3}{2}}$, in which c is a variable coefficie obtained (1) from the results of weir measurements made by Mr. F guson on 10-foot portion of the dam, and (2) from a study of t results of experiments made by George W. Rafter at the Corn testing flume.

When the flow of the river is less than 2,500 second-feet all of t water is generally used through the mill; at higher stages the excess wasted over the dam. The flow over the flashboards, which are u whenever possible, is computed by use of the formula $Q=3.33\ b\ H$ The area of the drainage basin at Millinockett is 1,880 square mil Several dams, which have been constructed at points in the basin ab this point, store water on a surface of practically 80 square mil This water is used for log driving and for manufacturing purpo Quakish Lake dam is at elevation 456.3 feet above mean sea level. determined by the Penobscot River survey of 1904.

Mean daily discharge, in second-feet, of Penobscot River at Millinocket, Me., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	237	413	403	315	(a)	4,705	4,088	2,366	2,027	3,005	2,255	(a)
2	141	360	407	284	2,266	4,566	4,894	4,977	2,389	(a)	2,261	2,261
3	159	410	416	560	2,294	4,247	4,490	4,988	2,020	2,186	2,251	2,292
4	417	401	389	338	2,150	4,151	4,520	4,982	2,653	(a)	2,326	2,204
5	405	409	414	221	2,297	4,844	4,247	4,958	2,420	2,298	2,336	2,285
6	421	403	109	582	2,332	4,746	4,309	2,424	2,014	2,026	2,298	2,250
7	436	200	368	1,013	2,326	5,345	4,330	2,077	2,018	2,313	2,271	2,002
8	392	436	404	681	2,116	4,900	2,448	2,308	2,026	2,363	2,347	2,359
9	398	415	392	702	(a)	4,353	4,535	4,913	1,996	2,350	2,367	2,366
10	385	448	397	436	2,235	4,353	2,031	4,936	2,024	2,437	2,331	(a)
11	430	423	391	639	2,306	4,209	3,386	4,936	2,390	2,077	2,318	(a)
12	393	438	492	1,019	2,332	4,197	3,076	4,939	2,331	2,062	2,355	(a)
13	345	430	467	995	2,315	4,730	3,068	4,924	2,041	2,341	2,394	(a)
14	244	198	737	1,087	2,384	3,848	2,219	4,659	2,400	2,048	2,310	(a)
15	362	411	724	973	5,100	3,193	2,010	4,789	2,019	2,005	(a)	2,200
16	438	433	828	859	5,010	2,433	2,007	4,937	2,023	2,311	(a)	2,000
17	216	434	799	1,095	10,255	2,415	3,093	4,959	(a)	2,015	(a)	2,250
18	376	434	421	1,056	11,314	2,417	2,031	4,921	2,162	2,026	(a)	2,005
19	332	433	793	1,094	11,682	2,277	2,392	2,347	2,339	2,423	(a)	2,010
20	205	403	488	1,112	11,673	2,418	2,906	2,014	2,025	2,042	(a)	(a)
21	428	188	788	1,108	10,671	2,434	4,097	2,027	2,018	2,059	2,293	(a)
22	414	200	814	1,473	7,043	2,454	2,420	2,178	2,327	2,049	2,291	(a)
23	297	200	462	1,457	7,324	2,433	2,037	2,008	(a)	2,015	2,289	(a)
24	149	275	470	1,072	9,276	2,424	3,658	2,378	(a)	2,310	2,255	2,003
25	450	426	453	1,473	8,645	3,125	2,005	2,017	2,212	2,403	(a)	2,000
26	416	415	818	1,463	5,266	5,028	2,019	2,002	2,005	2,055	(a)	2,549
27	431	404	615	1,469	4,737	4,757	3,663	2,000	2,002	2,067	2,555	2,003
28	214	189	823	1,807	3,710	4,171	(a)	2,312	2,023	2,077	2,302	2,012
29	238	368	408	1,802	3,831	3,106	(a)	2,022	2,003	2,027	2,003	(a)
30	249	.....	444	1,805	5,142	2,488	3,703	2,035	2,010	(a)	2,010	2,287
31	150	.....	420	.....	5,448	.....	2,005	2,119	.....	(a)	.....	2,002

[a] Owing to incompleteness of records discharge can not be computed.

PENOBSCOT RIVER AT WEST ENFIELD, ME.

This station was established by N. C. Grover on November 5, 1901, and in previous reports has been designated as being at Montague, Me. In 1904 the name of this village was changed to West Enfield. It is located at the steel highway bridge, about 1,000 feet below the mouth of Piscataquis River. The drainage area at this point is 6,630 square miles, including the area of the drainage basin of Chamberlain Lake (270 square miles), which flows into the Penobscot part of the year only.[a] The measurements are made from the bridge. A standard chain gage is fastened to the steel webbing on the upstream side of the bridge; length of chain, 34.49 feet. It is referred to bench marks as follows: (1) The top of the northwest corner of first course below bridge seat, easterly abutment; elevation, 25.78 feet. (2) Copper bolt in outcropping ledge under bridge, near east abutment; elevation, 6.71 feet. (3) Marked point on bottom chord of bridge, under gage;

[a] See description of St. John River drainage basin.

elevation, 29.52 feet. (All elevations are above gage datum and g datum is at an elevation of 125.38 feet above mean sea level, as de mined by the Penobscot River survey of 1904. The initial point soundings is on the easterly abutment, at the extreme end of the incl end post on downstream side of bridge. The channel is straight 1,000 feet above and 3,000 feet below the station, is about 870 wide, and is broken by four piers. The banks are high and ro and the bed permanent and rocky, with some gravel. The obse mean velocity has varied from 5.05 feet per second at gage he 12.90 to 1.08 feet per second at gage height 1.54. Water power is on both the Penobscot and Piscataquis rivers within a mile above station. Fluctuations at the gage of 0.2 or 0.3 of a foot during water are caused by changes in gate openings at the mills above. gage is read twice daily by A. H. Hanson, a merchant in West Enf

The observations at this station during 1904 have been made u the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Penobscot River at West Enfield, Me., in 1901–1904

Date	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Disch
1901.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second*
November 5	F. E. Pressey	2,200	1.38	2.00	:
1902.					
March 28	F. E. Pressey	11,380	5.05	12.80	5
April 8	do	9,520	4.62	10.90	4
July 15	N. C. Grover	4,650	2.42	5.10	1
August 28	F. E. Pressey	3,590	2.11	3.80	
September 15	do	3,680	2.11	3.90	
October 11	R. M. Connor	3,640	2.05	3.75	
1903.					
May 14	F. Collins	6,140	2.86	6.65	1
May 25	E. C. Murphy	3,960	2.12	4.10	
June 11	N. C. Grover	3,140	1.88	3.21	
August 7	F. E. Pressey	3,210	1.91	3.22	
October 15	N. C. Grover	1,920	1.08	1.54	
October 23	F. E. Pressey	1,970	1.20	1.58	
1904.					
April 26	N. C. Grover	8,770	3.67	9.70	3
May 18	F. E. Pressey	10,900	4.51	12.06	4
May 27	do	7,210	3.07	8.01	2
June 14	N. C. Grover	5,380	2.49	5.82	1
October 17	University of Maine students.[a]	4,000	2.02	4.23	
October 20	do	3,800	1.89	3.90	
October 25	do	5,000	2.16	5.25	1
October 31	do	4,450	2.16	4.73	

[a] Under direction of Prof. H. S. Boardman.

aily gage height, in feet, of Penobscot River at West Enfield, Me., for 1904.

	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
...	.....	[a] 2.80	.....	.....	12.30	7.20	4.25	4.05	2.80	7.05	4.65	3.20
...	.....	.....	.....	.....	12.00	6.80	5.15	3.70	2.70	6.90	4.45	3.15
...	.....	.....	.....	.....	11.60	7.75	5.90	4.30	2.80	6.30	4.45	3.40
...	[b] 3.50	.....	.....	6.15	11.20	7.15	6.20	4.70	2.80	5.65	4.30	3.45
...	.....	.....	.....	6.25	11.15	6.50	5.75	4.55	3.55	5.30	4.20	3.50
...	.....	.....	.....	6.50	10.65	6.90	5.45	4.40	3.70	5.05	4.10	3.50
...	.....	.....	[c] 2.70	6.75	10.10	7.20	5.10	4.15	3.65	4.75	4.15	3.45
...	.....	[d] 2.60	.....	7.60	9.10	7.55	4.70	4.05	3.35	4.65	4.50	3.70
...	.....	.....	.....	[e] 8.70	8.45	6.95	4.45	4.15	3.20	4.55	4.40	3.85
...	.....	.....	.....	9.65	8.45	6.60	4.35	4.10	3.20	4.35	4.30	4.25
...	[f] 3.30	.....	.....	10.75	10.10	6.50	5.00	4.20	3.10	4.20	4.20	4.25
...	.....	.....	.....	11.20	11.60	6.40	4.35	4.30	3.00	4.15	4.10	4.15
...	.....	.....	.....	11.00	11.80	6.20	4.25	4.20	3.05	4.10	4.05	(g)
...	.....	.....	[h] 4.90	10.40	10.90	5.90	4.50	4.10	2.75	4.20	4.05	.....
...	.....	[i] 2.40	.....	9.85	10.25	5.50	4.75	4.00	3.05	4.20	3.95	.....
...	.....	.....	.....	9.05	10.70	5.05	4.25	4.10	4.35	4.15	3.70	.....
...	.....	.....	.....	8.30	11.85	4.90	3.85	3.95	4.80	4.15	3.60	.....
...	[a] 3.40	.....	.....	7.90	11.90	5.20	4.50	3.75	4.50	4.10	3.50	.....
...	.....	.....	.....	7.80	11.55	5.85	3.80	3.50	4.15	4.05	3.60	[j] 4.30
...	.....	.....	.....	7.90	11.80	5.50	3.90	3.15	4.25	4.00	3.55	.....
...	.....	.....	[k] 4.70	7.80	12.00	5.15	4.05	3.45	4.10	3.90	3.55	.....
...	.....	[l] 2.60	.....	7.75	11.20	5.00	4.20	3.85	4.20	4.55	3.90	.....
...	.....	.....	.....	7.90	10.60	4.95	3.50	3.55	4.10	5.80	3.85	.....
...	.....	.....	.....	8.20	10.45	4.75	3.40	3.40	4.15	5.65	3.85	.....
...	[a] 3.20	.....	.....	8.60	9.90	4.55	3.65	3.30	4.75	5.25	3.80	.....
...	.....	.....	.....	9.85	8.80	4.65	3.35	3.15	5.30	5.05	3.70	[m] 4.30
...	.....	.....	.....	10.15	8.05	4.90	3.80	2.95	5.10	5.45	3.65	.....
...	.....	.....	[a] 6.00	10.25	7.95	4.75	4.15	2.70	4.65	5.65	3.40	.....
...	.....	[n] 2.40	.....	10.35	7.60	4.15	3.45	2.80	4.85	5.45	3.30	.....
...	.....	.....	.....	11.10	7.30	3.75	3.25	2.80	5.45	5.10	3.20	.....
...	.....	.....	.....	.....	7.35	.....	3.30	2.75	.....	4.70	.....	.....

uring frozen season readings are to surface of water in hole cut in ice.

eet thick.
: thick.
et thick.
eet thick.

[c] Clear of ice.
[f] Ice 1.1 feet thick.
[g] Frozen over.
[h] Ice 1.5 feet thick.

[i] Ice 1.35 feet thick.
[j] Ice 0.65 foot thick.
[k] Ice 1.4 feet thick.
[l] Ice 1.5 feet thick.

[m] Ice 0.75 foot thick.
[n] Ice 1.65 feet thick.

Rating table for Penobscot River at West Enfield, Me., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.7	4,420	4.1	7,740	6.0	13,580	8.8	26,620
2.8	4,620	4.2	8,020	6.2	14,270	9.0	27,860
2.9	4,830	4.3	8,310	6.4	14,980	9.2	29,100
3.0	5,050	4.4	8,600	6.6	15,720	9.4	30,360
3.1	5,270	4.5	8,900	6.8	16,500	9.6	31,640
3.2	5,500	4.6	9,200	7.0	17,300	9.8	32,960
3.3	5,730	4.7	9,500	7.2	18,140	10.0	34,300
3.4	5,960	4.8	9,800	7.4	19,020	10.5	37,760
3.5	6,200	4.9	10,100	7.6	19,940	11.0	41,320
3.6	6,440	5.0	10,400	7.8	20,920	11.5	45,000
3.7	6,690	5.2	11,000	8.0	21,980	12.0	48,820
3.8	6,940	5.4	11,620	8.2	23,080	12.5	52,780
3.9	7,200	5.6	12,260	8.4	24,220	13.0	56,920
4.0	7,470	5.8	12,910	8.6	25,040		

The above table is applicable only for open-channel conditions. It is based upo 8 discharge measurements made during 1904. It is well defined between gage heigh 3.90 feet and 12.10 feet. The table has been extended beyond these limits, and uncertain below gage height 3.9 feet. The discharge as given by the 1904 curve several per cent smaller than the 1903 curve, owing to obstructions in the river belo the station.

Estimated monthly discharge of Penobscot River at West Enfield, Me., for 1904.

[Drainage area, 6,630 square miles.][a]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth inche
April 9–30	42,780	20,670	30,110	4.54	3.7
May	51,180	18,580	36,880	5.56	6.4
June	20,670	6,815	13,200	1.99	2.2
July	14,270	5,615	8,540	1.29	1.4
August	9,500	4,520	6,889	1.04	1.2
September	11,780	4,420	7,239	1.09	1.2
October	17,510	7,200	10,240	1.54	1.7
November	9,350	5,500	7,335	1.11	1.2
December 1–12	8,165	5,385	6,615	.998	.4

[a] Includes Chamberlain Lake drainage. See description of St. John River drainage basin.

PENOBSCOT RIVER (EAST BRANCH) AT GRINDSTONE, ME.

This station was established October 23, 1902, by F. E. Presse It is located at the Bangor and Aroostock Railroad bridge, one-half m south of the railway station. The measurements are made from t

railway bridge. The drainage area at this point is 1,130 square miles, including the Chamberlain Lake basin (270 square miles). The initial point for soundings is on the left bank, at the lower end of the inclined end post. The gage is of the standard chain type; length of chain, 31.99 feet. The scale board is nailed to the guard timber on the upstream side of the bridge. It is referred to the following-described bench marks: (1) Southwest corner of bridge seat on east abutment; elevation, 26.32 feet. (2) Copper bolt in ledge under north end of bridge; elevation, 8.78 feet. (3) Marked point on center stringer, near gage; elevation, 29.78 feet. All elevations are above gage datum. The channel both above and below this station is straight. The flow is moderately rapid at medium and high stages of the river. Observed mean velocities range from 2.27 feet per second at gage height 8.10 feet, to 0.18 foot per second at gage height 4.32 feet. Fluctuations in stage are usually slow, as no water power is used on the river above the station. Dams are maintained at the outlets of several of the lakes and ponds near the source of the river, and the impounded water is used for log driving. The bed is rocky and permanent; the stream is confined to the channel by the abutments of the bridge and has a width of about 275 feet, broken by one pier. Practically all land areas in this basin are in forest. The gage is read twice daily by Harry Stinson.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Penobscot River (East Branch) at Grindstone, Me., 1902–1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1902.		*Feet.*	*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
October 23	F. E. Pressey	226	1,410	0.50	5.15	706
November 26	do	225	1,490	.62	5.41	921
1903.						
April 9	N. C. Grover	262	2,170	2.15	7.85	4,670
April 14	do	266	2,270	2.36	8.10	5,350
April 22	F. E. Pressey	258	1,930	1.67	7.20	3,230
May 23	C. N. McCulloch	245	1,830	1.41	6.64	2,580
September 9	N. C. Grover	228	1,270	.17	4.32	223
September 26	do	236	1,510	.54	5.36	824
October 28 [a]	F. E. Pressey	230	648	.73	4.58	474
1904.						
April 29	N. C. Grover	270	2,450	3.34	9.13	8,180
October 24	F. E. Pressey	247	1,740	1.28	6.32	2,230

[a] Measurement made from boat.

Mean daily gage height, in feet, of Penobscot River (East Branch) at Grindstone, Me., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1					10.30	8.70	6.10	7.00	4.60	7.15	5.60	.....
2					10.80	8.60	6.30	6.80	4.60	7.30	5.60	.....
3	4.20				10.25	8.20	6.60	6.60	4.70	7.30	5.60	a4.3
4				b4.80	9.60	7.25	6.80	6.60	5.40	6.90	5.30	.....
5					9.60	7.35	6.80	6.70	5.60	6.55	5.30	.....
6			c3.40		9.40	8.20	6.40	6.80	5.40	6.30	5.30	.....
7		d3.30			8.40	7.90	6.20	6.95	5.05	6.10	5.30	.....
8					7.65	7.90	6.20	7.00	5.00	6.05	5.30	.....
9					7.30	8.05	6.20	7.00	5.00	5.90	5.30	.....
10	e3.50			6.50	7.75	8.20	6.20	7.00	4.80	5.80	5.30	f4.
11					8.30	8.20	6.20	7.00	4.70	5.80	5.20	...
12					9.05	8.20	6.20	6.80	4.70	5.85	5.20	...
13			g3.40		9.50	8.05	6.20	6.80	4.70	5.60	5.30	...
14		d3.30			8.65	8.05	6.05	5.40	4.70	5.60	5.30	...
15					8.60	6.30	5.65	5.80	5.10	5.60	5.20	...
16					7.30	6.40	5.60	5.80	6.20	5.60	5.30	..
17	b3.50			6.50	8.70	6.50	6.10	5.55	5.25	5.60	5.30	..
18				6.50	8.15	6.60	6.40	5.45	5.60	5.50	5.30	e
19				6.50	8.40	6.15	6.55	5.25	5.65	5.50	5.30	..
20			h3.60	6.50	8.75	5.30	6.60	5.20	5.70	5.40	5.30	..
21		d3.30		6.70	9.00	5.50	6.80	5.50	5.55	5.40	5.30	..
22				7.00	7.65	5.40	6.80	5.30	5.35	6.90	5.30	..
23				7.20	7.95	5.10	6.95	5.30	5.30	7.15	5.30	..
24	b3.50			7.20	7.90	5.10	7.20	5.40	5.30	6.35	5.30	..
25				7.75	7.45	5.10	7.20	5.20	5.80	6.30	5.30	a
26					8.30	7.20	5.20	7.20	5.20	6.05	6.20	j5.30 ..
27			k4.40		9.00	7.90	5.20	7.20	5.20	6.10	6.10	....
28		k3.20			9.20	8.70	5.20	7.20	4.90	6.10	6.00	....
29					9.20	8.90	5.20	7.20	4.85	6.55	6.00	a5.30 ..
30					9.90	8.70	5.90	7.20	4.70	6.90	5.75	....
31	b3.50					8.70	.....	7.10	4.60	.....	5.60	 l

a Ice 0.85 feet thick.
b Ice 1.35 feet thick.
c Ice 2.15 feet thick.
d Ice 1.7 feet thick.
e Ice 1.15 feet thick.
f Ice 1 foot thick.
g Ice 2.1 feet thick.
h Ice 2 feet thick.
i Ice 1.4 feet thick. Gage height to top of ice=6.6 feet.
j River frozen November 26.
k Ice 1.85 feet thick.
l Ice 1.6 feet thick. Gage height to top of ice=4.7 feet.

NOTE.—During frozen season gage readings are to surface of water in hole cut in ice.

ating table of Penobscot River (East Branch) at Grindstone, Me., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.7	190	4.8	480	6.2	1,755	8.2	5,580
3.75	196	4.9	534	6.3	1,895	8.4	6,090
3.8	202	5.0	593	6.4	2,040	8.6	6,630
3.85	209	5.1	660	6.5	2,190	8.8	7,190
3.9	216	5.2	735	6.6	2,350	9.0	7,770
3.95	224	5.3	815	6.7	2,510	9.2	8,350
4.0	233	5.4	900	6.8	2,675	9.4	8,940
4.1	252	5.5	990	6.9	2,845	9.6	9,540
4.2	273	5.6	1,085	7.0	3,020	9.8	10,140
4.3	296	5.7	1,185	7.2	3,390	10.0	10,750
4.4	323	5.8	1,285	7.4	3,790	10.2	11,370
4.5	356	5.9	1,395	7.6	4,205	10.4	11,990
4.6	393	6.0	1,505	7.8	4,640	10.6	12,610
4.7	434	6.1	1,625	8.0	5,100	10.8	13,230

The above table is applicable only for open-channel conditions. It is based upon 11 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 4.5 feet and 8 feet. Above gage height 8 feet the curve is somewhat uncertain. The table has been extended beyond these limits.

Estimated monthly discharge of Penobscot River (East Branch) at Grindstone, Me., for 1904.

[Drainage area, 1,130 square miles.] [a]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April 17–30	10,440	2,190	4,738	4.19	2.18
May	13,230	3,390	6,799	6.02	6.94
June	6,910	660	3,074	2.72	3.03
July	3,390	1,085	2,349	2.08	2.40
August	3,020	393	1,629	1.44	1.66
September	2,845	393	982	.869	.970
October	3,590	900	1,739	1.54	1.78
November 1–25	1,085	735	841	.744	.692

[a] Drainage area includes Chamberlain Lake drainage basin of 270 square miles. See description of St. John River drainage basin.

MATTAWAMKEAG RIVER AT MATTAWAMKEAG, ME.

This station was established August 26, 1902, by F. E. Pressey. It is located at the Maine Central Railroad bridge in the village of Mattawamkeag. The area of the drainage basin at this point is 1,510 square miles. The initial point for soundings is on the south abutment at the lower end of the inclined end post of the downstream truss. The gage is of the standard chain type; length of chain, 33.40 feet. The scale board is nailed to the guard timber of the lower side of the bridge. It is referred to bench marks, as follows: (1) Southwest corner of bridge seat of north abutment; elevation, 26.87 feet. (2) Copper bolt in bowlder north of bridge and west of railroad; elevation, 19.01 feet. (3) Marked point on stringer near gage; elevation, 31.42 feet. All elevations are above gage datum, and gage datum is at elevation 185.93 feet above mean sea level, as determined by the Penobscot River survey of 1904. The channel both above and below this station is straight, and has a width of about 400 feet at ordinary stages, broken by two piers. The bed of the stream is rocky and permanent. The water is confined to the channel by the abutments of the bridge. The observed mean velocities at this station have been between 4.11 feet per second at gage height 9.15 feet and 0.90 of a foot per second at gage height 2.75 feet. Low-water measurements are made by wading at a point about 1 mile above the station, where the velocities are greater than at the bridge and the bed is gravelly. The bridge is slightly oblique to the thread of the stream.

Dams are maintained at the outlets of several of the lakes and ponds in this basin, and the stored water is used for driving logs. Probably 90 per cent of the land surface is in forest. The gage is read twice daily by W. T. Mincher.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

measurements of Mattawamkeag River at Mattawamkeag, Me., 1902–1904.

	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
....	F. E. Pressey	550	2.13	4.40	1,170
....	do	685	2.34	4.70	1,600
6 ..	do	815	2.06	5.00	1,680
....	do	1,160	2.63	5.89	3,050
....	F. E. Pressey	2,380	4.11	9.15	9,780
....	do	1,560	3.47	7.15	5,410
....	do	540	2.33	4.58	1,260
....	C. N. McCulloch	530	2.09	4.45	1,110
....	F. E. Pressey	355	2.09	4.02	742
....	do	310	1.80	3.87	558
1 ..	N. C. Grover	220	1.55	3.39	340
....	do	135	.90	2.75	121
....	F. E. Pressey	204	1.47	3.32	300
....	F. E. Pressey	2,690	4.68	9.85	12,600
....	N. C. Grover	2,510	4.55	9.50	11,400
...	F. E. Pressey	727	2.42	5.07	1,760

[a] Measurement made by wading.

age height, in feet, of Mattawamkeag River at Mattawamkeag, Me., for 1904.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	.....	.....	10.70	6.40	4.50	3.75	3.50	6.10	5.40	5.20
.....	.....	.....	.....	11.00	6.30	4.50	3.50	3.40	6.45	5.30	5.10
[a] 4.60	.....	.....	.....	11.10	6.20	4.75	3.65	3.45	6.60	5.20	5.00
.....	.....	.....	.....	11.00	6.20	4.90	3.70	3.60	6.45	4.95	5.10
.....	.....	.....	.....	10.75	6.25	4.90	3.70	3.75	6.25	4.85	5.20
.....	.....	[b] 5.00	.....	10.40	6.50	4.90	3.70	4.10	6.05	5.15	5.30
.....	[b] 4.20	.....	.....	10.10	6.95	4.90	3.70	4.40	5.85	5.15	5.50
.....	.....	.....	[c] 8.20	9.95	7.05	4.85	3.55	4.30	5.65	5.10	5.80
.....	.....	.....	7.60	9.45	6.80	4.70	3.40	4.20	5.45	5.10	5.80
[d] 4.40	.....	.....	8.20	9.40	6.70	4.70	3.55	4.05	5.30	5.05	5.70
.....	.....	.....	9.00	9.15	6.60	4.30	3.70	4.00	5.30	4.90	5.70
.....	.....	.....	9.75	9.65	6.50	4.20	3.80	3.90	5.20	4.80	5.70
.....	.....	[b] 6.30	9.95	10.85	6.20	4.30	3.80	3.90	5.10	4.80	5.70
.....	[b] 4.20	.....	10.05	11.40	6.10	4.30	3.80	3.80	5.25	4.75	5.60
.....	.....	.....	9.90	11.70	6.05	4.40	3.75	4.25	5.40	4.65	5.50
.....	.....	.....	9.65	11.55	6.00	4.50	3.55	4.55	5.40	4.40	5.40

t thick. [b] Ice 1.7 feet thick. [c] River clear of ice. [d] Ice 1.6 feet thick.

Mean daily gage height, in feet, of Mattawamkeag River at Mattawamkeag, Me., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
17	[a] 4.10	.....	.....	9.50	11.30	6.00	4.45	3.60	4.90	5.30	4.40	5.30
18	.....	.....	.....	9.10	10.75	6.00	4.35	3.80	5.05	5.20	4.55	5.20
19	.....	.....	.....	8.90	9.65	6.00	4.10	3.90	5.00	5.20	4.80	5.10
20	.....	.....	[a] 6.30	8.80	9.35	5.85	4.20	3.90	5.10	5.10	5.10	5.00
21	.....	[a] 4.30	.....	8.70	9.35	5.45	4.10	4.00	5.20	5.00	4.80	([b])
22	.....	.....	.....	8.70	8.75	5.15	4.05	4.00	5.10	5.15	4.70	.....
23	.....	.....	.....	8.70	8.60	4.95	4.00	4.00	5.20	5.45	4.75	.....
24	[a] 4.00	.....	.....	8.75	8.55	4.80	3.90	4.00	5.20	5.50	5.00	.....
25	.....	.....	.....	9.05	8.35	4.65	3.85	4.00	5.35	5.60	4.95	.....
26	.....	.....	.....	9.35	7.80	4.45	3.60	4.00	5.65	5.75	5.15	[c] 4.30
27	.....	.....	[d] 6.30	9.55	7.55	4.35	3.70	3.85	5.80	5.90	5.30	.....
28	.....	[a] 4.50	.....	9.75	7.50	4.45	3.80	3.70	5.80	5.90	5.20	.....
29	.....	.....	.....	9.95	7.20	4.60	3.80	3.70	5.70	6.00	5.20	.....
30	.....	.....	.....	10.30	6.75	4.60	3.90	3.65	5.75	5.85	5.20	.....
31	[a] 4.20	.....	.....	.....	6.50	.....	3.90	3.65	.....	5.65	.....	.....

[a] Ice 1.7 feet thick.
[b] River frozen over.
[c] Ice 0.4 foot thick.
[d] Ice 1.4 feet thick.

NOTE.—During frozen season gage readings are to surface of water in hole cut in ice.

Rating table of Mattawamkeag River at Mattawamkeag, Me., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.7	110	3.9	630	5.4	2,350	7.8	6,800
2.75	121	4.0	710	5.5	2,500	8.0	7,260
2.8	133	4.1	790	5.6	2,650	8.2	7,740
2.85	146	4.2	880	5.7	2,810	8.4	8,235
2.9	160	4.3	975	5.8	2,970	8.6	8,740
2.95	175	4.4	1,075	5.9	3,135	8.8	9,260
3.0	191	4.5	1,175	6.0	3,305	9.0	9,780
3.1	226	4.6	1,285	6.2	3,645	9.5	11,170
3.2	262	4.7	1,400	6.4	3,995	10.0	12,570
3.3	300	4.8	1,520	6.6	4,355	10.5	14,070
3.4	340	4.9	1,650	6.8	4,725	11.0	15,600
3.5	382	5.0	1,790	7.0	5,110	11.5	17,200
3.6	432	5.1	1,930	7.2	5,510		
3.7	490	5.2	2,070	7.4	5,930		
3.8	556	5.3	2,210	7.6	6,360		

The above table is applicable only for open-channel conditions. It is based up 16 discharge measurements made during 1902 to 1904, inclusive. It is well defin between gage heights 2.7 feet and 10 feet. The table has been extended above ga height 10 feet. Below gage height 7.2 feet the table is the same as the 1903 table.

Estimated monthly discharge of Mattawamkeag River at Mattawamkeag, Me., for 1904.

[Drainage area, 1,510 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April 8–30	13,470	6,360	10,360	6.86	5.87
May	17,840	4,175	11,590	7.68	8.85
June	5,210	1,025	3,088	2.04	2.28
July	1,650	432	1,014	.672	.775
August	710	340	534	.354	.408
September	2,970	340	1,440	.954	1.06
October	4,355	1,790	2,725	1.80	2.08
November	2,350	1,075	1,743	1.15	1.28
December 1–20	2,970	1,790	2,359	1.56	1.16

PISCATAQUIS RIVER NEAR FOXCROFT, ME.

This station was established August 17, 1902, by F. E. Pressey. It is located at Low's bridge, about halfway between Guilford and Foxcroft. The area of the drainage basin at this point is 280 square miles. The initial point for soundings is on the left bank at the top of the face of the left abutment. The gage is a painted staff spiked to the left abutment. It is referred to bench marks as follows: (1) Top of second course from top of left abutment; elevation, 17.80 feet. (2) Copper bolt in ledge, 150 feet north of highway and 75 feet west of river; elevation, 20.97 feet. (3) Marked point on bottom chord of upstream truss of bridge, 30 feet from initial point; elevation, 21.80 feet. All elevations are above gage datum. The channel both above and below the station is straight and has a width of about 90 feet at ordinary stages. The banks are high and rocky; the bed is rough and rocky, but permanent.

Observed mean velocities at the station have been between 3.63 feet per second at gage height 4.30 feet and 0.54 of a foot at gage height 2 feet. Low-water measurements are made by wading, either above or below the bridge, at points where the bed is fine gravel, and the velocity is greater than at the bridge. Water power is used at several manufacturing plants within a few miles above the station. As a result of the interruptions, due to the irregular use of water at the mills, the river fluctuates, at low stages, through nearly a foot on the gage within the day. The small amount of stored water in this basin is generally used for log driving. Slopes are steep. The river rises and falls rapidly. Probably 50 per cent of the basin is in forest. The gage is read twice daily by A. F. D. Harlow.

The observations at this station during 1904 have been made u the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Piscataquis River near Foxcroft, Me., 1902–1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Disc
1902.		*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Seco*
August 13	F. E. Pressey	317	3.15	3.70	
August 16	do	199	1.67	2.80	
September 10	do	189	1.52	2.75	
October 18	do	112	.54	2.00	
1903.					
April 6	F. E. Pressey	409	3.63	4.30	
May 14	E. G. Hartford	210	1.76	2.80	
May 14	do	210	1.76	2.79	
June 12	F. E. Pressey	156	1.03	2.48	
June 12	do	164	1.27	2.64	
June 12	do	156	1.08	2.47	
September 16	N. C. Grover	136	.82	2.19	
October 3 [a]	do	11	2.00	1.52	
October 31 [a]	F. E. Pressey	22	1.41	1.78	
October 31 [a]	do	118	.67	1.94	
October 31 [a]	do	79	.47	1.78	
November 24 [a]	do	139	1.30	2.50	
1904.					
April 22	F. E. Pressey	355	3.35	4.00	
May 13	do	610	6.31	5.92	
May 13	do	620	6.31	5.98	
June 2	N. C. Grover	208	1.99	2.90	

[a] Measurements by wading.

Mean daily gage height, in feet, of Piscataquis River near Foxcroft, Me., for 1

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	3.0	3.8	3.0	4.7	7.0	2.4	3.2	2.3	2.0	4.0	3.2
2	3.0	3.4	3.0	4.6	5.6	2.3	3.4	2.4	2.0	4.0	3.2
3	3.0	3.0	3.0	4.5	5.2	2.3	3.7	2.2	2.0	3.6	3.(
4	3.1	2.9	3.1	4.3	5.5	2.3	3.7	2.1	2.5	3.5	3.(
5	3.0	2.8	3.3	4.2	4.9	2.7	3.6	2.1	2.6	3.2	3.(
6	3.2	2.8	3.6	5.0	4.8	3.4	3.2	2.1	2.6	3.2	2.8
7	3.2	2.2	3.6	5.0	4.6	4.2	3.2	2.1	2.6	3.0	3.(
8	3.0	2.8	3.8	5.5	3.8	3.6	3.0	2.1	2.6	3.0	3.(
9	2.9	2.8	4.4	5.8	4.0	3.3	3.0	2.2	2.6	2.4	3.(
10	2.5	2.8	4.9	7.0	6.4	3.2	2.9	2.2	2.2	2.2	3.(
11	3.2	2.8	5.2	10.2	6.9	2.6	2.9	2.4	3.6	2.6	3.(
12	3.2	2.6	5.0	8.6	8.2	2.0	2.9	2.4	3.3	2.6	3.(

Mean daily gage height, in feet, of Piscataquis River near Foxcroft, Me., for 1904—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	3.2	2.5	4.6	6.2	6.2	2.0	3.0	2.4	2.2	2.6	2.6	2.7
.....	3.4	2.6	4.6	4.6	5.4	2.3	3.2	2.4	2.3	2.6	3.0	2.5
.....	3.4	2.8	4.5	4.2	4.4	2.3	3.2	2.7	2.8	2.7	3.1	2.4
.....	3.5	2.8	4.4	4.0	5.8	2.5	3.0	2.6	3.5	2.6	3.6	2.4
.....	3.5	2.8	4.2	3.8	6.6	2.7	2.8	2.6	3.0	2.6	3.2	2.4
.....	3.7	2.8	4.2	3.6	5.6	2.7	2.8	2.6	2.8	2.6	3.0	2.1
.....	3.9	2.7	3.9	3.8	4.8	2.7	2.7	2.6	3.0	2.6	2.8	2.8
.....	3.4	2.4	3.8	4.0	5.0	2.7	2.7	2.6	3.0	2.6	2.6	3.0
.....	3.2	2.0	3.8	4.1	4.4	2.7	2.7	2.9	2.8	3.0	2.8	2.8
.....	3.2	2.4	3.8	4.0	4.2	2.6	2.6	3.0	2.8	4.5	2.9	2.8
.....	3.3	2.8	3.6	4.0	4.3	2.6	2.5	2.9	2.8	3.9	3.0	2.8
.....	3.2	3.0	4.3	4.8	4.0	2.6	2.4	2.7	2.7	3.5	2.8	2.8
.....	3.7	3.2	4.4	5.2	3.7	2.6	2.3	2.6	2.6	3.2	2.9	2.6
.....	3.2	3.0	4.6	5.4	3.0	2.5	2.3	2.6	2.6	3.4	2.8	2.8
.....	3.4	3.0	5.1	5.4	3.6	3.1	2.3	2.3	2.7	4.0	2.5	2.8
.....	3.2	3.0	5.2	5.4	3.5	3.0	2.4	2.2	2.7	3.8	2.6	3.2
.....	2.9	2.9	5.0	6.0	3.3	2.7	2.3	2.4	2.8	3.5	2.6	3.0
.....	3.0	.....	4.8	6.7	3.4	2.6	2.3	2.2	4.0	3.4	2.4	2.8
.....	3.0	.....	4.6	.....	3.4	.....	2.3	2.1	.....	3.2	.....	2.8

ating table of Piscataquis River near Foxcroft, Me., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.0	64	2.7	267	3.8	1,023	5.2	2,635
2.05	72	2.75	292	3.9	1,113	5.3	2,785
2.1	81	2.8	318	4.0	1,208	5.4	2,940
2.15	90	2.85	345	4.1	1,303	5.5	3,100
2.2	100	2.9	374	4.2	1,403	5.6	3,265
2.25	111	2.95	405	4.3	1,508	5.8	3,610
2.3	123	3.0	437	4.4	1,615	6.0	3,970
2.35	135	3.1	502	4.5	1,725	6.2	4,335
2.4	148	3.2	569	4.6	1,840	6.4	4,705
2.45	163	3.3	638	4.7	1,960	6.6	5,080
2.5	180	3.4	709	4.8	2,085	6.8	5,460
2.55	199	3.5	782	4.9	2,215		
2.6	220	3.6	858	5.0	2,350		
2.65	243	3.7	938	5.1	2,490		

The above table is applicable only for open-channel conditions. It is based upo 0 discharge measurements made during 1902 to 1904, inclusive. It is well defined etween gage heights 1.5 feet and 6.0 feet. The table has been extended beyond hese limits.

Estimated monthly discharge of Piscataquis River near Foxcroft, Me., for 1904.

[Drainage area, 280 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dep in
January	1,113	180	587	2.10	
February	1,023	64	348	1.24	
March	2,635	437	1,459	5.21	
April	15,050	858	3,004	10.7	1
May	8,840	437	2,532	9.04	1
June	1,403	64	319	1.14	
July	938	123	388	1.39	
August	437	81	174	.621	
September	1,208	64	325	1.16	
October	1,725	100	587	2.10	
November	858	148	395	1.41	
December	569	81	273	.975	
The year	15,050	64	866	3.09	

COLD STREAM AT ENFIELD, ME.

Cold Stream is the outlet from Cold Stream Pond—really a seri ponds comprising a total area of water surface of about 10 s miles, the largest, which is mostly in the town of Enfield, h about 8 square miles area.

Cold Stream flows into Passadumkeag Stream, a tributary o Penobscot, at a distance of some 4½ miles from Cold Stream Pon has a total drainage area of about 37 square miles. The basin is m wooded and only sparsely settled. During the first half mile th is rapid, but through the rest of its course the stream runs thro great swamp, and is tortuous in its course, with sluggish cu Near the village of Enfield a fall of perhaps 10 to 12 feet has i past been developed for power for a saw and shingle mill, but i now in use. This drainage basin has been considered as a sour water supply for the district, which includes Bangor and some adjacent towns.

This station was established June 14, 1904, by N. C. Grover was located at the highway bridge, about three-fourths of a mile of Enfield, on the road to Passadumkeag. During the summer i found that the gage was within the influence of back water Passadumkeag Stream, and consequently, on September 12, 190 gage was taken from the highway bridge mentioned above and p

00 feet below the old mill, near Enfield post-office. The drain-
a at this point is about 26 square miles.

gage is a standard chain, attached to a clump of maple trees on
ht bank of the river; length of chain, 10.24 feet. It is referred
following bench marks: (1) Spike in maple tree near the gage;
on, 6.89 feet above gage datum. (2) Point on a rock marked
.—2," about 8 feet downstream from the gage on the right
elevation, 4.55 feet above gage datum. (3) Center of the gage-
lley; elevation, 9.03 feet above gage datum. Discharge meas-
its are made at low and medium stages by wading in the vicinity
gage. High-water measurements are made from the bridge
00 feet above the gage. The stream is fairly straight in the
of the gage, and is about 30 feet wide at ordinary stages. The
the stream is rocky and permanent; the banks are not high and
ly overflow at high stages. The width is about 30 feet; depth
).9 of a foot; velocity is high at all stages. The gage is read
y Mr. A. J. Twombley, a farmer, at Enfield.

observations at this station during 1904 have been made under
ection of H. K. Barrows, district hydrographer.

Discharge measurements of Cold Stream at Enfield, Me., in 1904.

te.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
er 9	H. K. Barrows	17	2.12	2.72	36
12	F. E. Pressey	20	1.85	2.75	37
21	do	23	2.43	2.92	56
er 4	do	25	2.16	2.90	54

Mean daily gage height, in feet, of Cold Stream at Enfield, Me., for 1904.

.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
		2.9	2.9	2.6	17	2.9	3.0	2.7	2.7
		2.9	2.8	2.7	18	2.9	3.0	2.9	2.7
		2.9	2.8	2.7	19	2.8	3.0	2.8	2.6
		2.9	3.0	2.7	20	2.8	3.0	2.7	2.7
		3.0	2.8	2.8	21	2.8	2.8	2.8	2.6
		2.8	2.8	2.8	22	2.8	3.0	2.8	2.7
		2.8	2.8	2.7	23	2.8	3.0	2.7	2.7
		2.8	2.8	2.7	24	2.9	3.0	2.6	2.7
		2.9	2.8	2.7	25	2.9	3.0	2.7	2.6
	2.4	2.8	2.8	2.8	26	2.8	3.0	2.8	2.6
	2.8	2.5	2.8	2.7	27	2.8	3.0	2.8	2.7
	2.8	2.7	2.8	2.8	28	2.8	3.0	2.8	2.7
	2.7	2.7	2.7	2.8	29	2.8	3.0	2.7	2.6
	2.7	2.7	2.7	2.7	30	3.0	3.0	2.6	2.7
	2.9	2.7	2.7	2.6	31		3.0		2.6
	2.9	2.8	2.7	2.6					

PHILLIPS LAKE AND OUTLETS IN HOLDEN AND DEDHAM, ME.

Phillips Lake drains an area of about 11.5 square miles, and has a water surface of about 1.4 square miles. It is situated about 10 miles southeast of the city of Bangor. The shores are generally rocky and the adjacent country mostly wooded and only sparsely settled. The water is apparently of excellent quality and of considerable depth. This lake is being prominently considered as a new source of water supply for the city of Bangor. There are two drainage outlets of this lake. The greater amount of water flows from the northern end of the lake northerly through the village of East Holden; thence southerly through Long Pond and into Penobscot River below Bucksport. The total length of this outlet is 18 miles. The other outlet, situated at the southeast end of the lake in the town of Dedham, flows into Green Lake and thence into Union River. Through this outlet there is flow only during medium and high stages.

The United States Geological Survey maintains gages at the two outlets of the lake; also a gage for obtaining a record of lake level.

The station at the northern outlet was established July 7, 1904, by F. E. Pressey. It is located about 1¼ miles from the lake, one-fourth mile south of the village of East Holden and 175 feet south of an old mill. The drainage area at this point is 12.3 square miles. A plain staff gage was first used, attached vertically to a maple tree on the right bank, but this was replaced on December 6, 1904, by a standard chain gage attached to the same maple tree; length of chain, 9.48 feet. The gage is referred to bench marks as follows: (1) A spike, approximately vertical, in the foot of the tree to which the gage is attached, inclosed in a circle and marked "B. M.—1"; elevation, 5.24 feet above the gage datum. (2) The highest point on a large stone about 25 feet upstream from the gage in the bed of the stream. It is inclosed in a circle and marked "B. M.—2"; elevation, 5.51 feet above gage datum. (3) Spike driven into maple tree to which gage is attached, approximately horizontal, for use in measuring to the water surface; elevation, 6.17 feet above gage datum. (4) Center of gage-box pulley; elevation, 8.30 feet above gage datum.

Discharge measurements are made at ordinary stages by wading near the gage. At high water they are made from a railroad bridge about one mile upstream. The channel is straight for about 10 or 12 feet above the gage and curved just below the gage. The bed is rocky and rough but permanent. The banks are high and not subject to overflow. There is but one channel at all stages. The ordinary width is about 10 feet; depth, 0.8 of a foot; velocity, high at all stages. The gage is read once each day by Lewis Pinkham, of East Holden.

The station at the southeast outlet was established July 19, 1904, by H. K. Barrows. It is located at the highway bridge about 1½ miles

southeast of Lake House railroad station, and is about 700 feet southeast of the Maine Central Railroad crossing. A plain staff gage is fastened vertically to the logs of the floor and the right abutment of the single-span highway bridge. It is referred to bench marks as follows: (1) A point and circle on stone of the southeast abutment of the bridge marked "B. M.—1"; elevation, 6.31 feet above the gage datum. (2) Highest point of stone about 50 feet north of the gage on the west side of the road, inclosed by a circle and marked "B. M.—2"; elevation, 10.04 feet above the gage datum.

Discharge measurements are made at low and medium stages by wading just below the bridge, and at high stages from the downstream side of the bridge to which the gage is attached. The channel is curved for about 25 feet above the station and straight for some 30 feet below. The bed of the stream is of gravel, rough but permanent. The banks are rocky, wooded, and liable to overflow. There is but one channel at all stages. The gage is read only when meter measurements are made.

The station on Phillips Lake was established July 19, 1904, by H. K. Barrows. It is located about one-fourth mile west of Lake House railroad station. The gage is a plain, vertical staff fastened to a bowlder on the east shore of the lake about 300 feet northwest of Dr. L. S. Chilcott's cottage. It is referred to bench marks as follows: (1) A point on ledge of rock east of the gage, inclosed by a circle and marked "B. M.—1"; elevation, 10.28 feet above gage datum. (2) A point on a ledge of rock about 10 feet west of the gage, inclosed by a circle and marked "B. M.—2"; elevation, 11.86 feet above gage datum. This gage has been read at intervals of a week or two, and results furnished through the courtesy of Dr. L. S. Chilcott, of Bangor, during the summer and fall of 1904.

An additional vertical staff gage, referred to the same datum, was established on December 6, 1904. It is fastened to the east abutment of the Maine Central Railroad bridge over the northern end of Phillips Lake. It is referred to bench marks as follows: (1) The northwest corner of wing wall at west end of bridge; elevation, 16.79 feet above gage datum. This gage is read once a week by H. C. Lord, section foreman of the Maine Central Railroad, who lives at East Holden.

Observations at these stations during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Phillips Lake, north outlet, at East Holden, Me., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 19	H. K. Barrows	7.86	1.23	1.55	9.66
August 18	F. E. Pressey	6.54	.97	1.45	6.29
October 17	do	4.36	1.29	1.46	5.64

Discharge measurements of Phillips Lake, southeast outlet, near Greenlake, Me., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 19	H. K. Barrows	1.23	0.89	1.42	1.09
August 18	F. E. Pressey	.20	.35	1.14	.07
October 17	do	1.25	1.18	1.49	1.48

Mean daily gage height, in feet, of Philips Lake, north outlet, at East Holden, Me., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.70	1.45	(a)	1.45	1.80
2		1.70	1.50		1.45	1.90
3		1.65	1.48		1.45	2.00
4		1.65	1.45		1.45	1.80
5		1.65	1.45		1.45	1.70
6		1.60	1.45		1.45	1.70
7	1.60	1.60	1.45		1.45	1.70
8	1.60	1.60	1.45		1.45	1.70
9	1.60	1.60	1.45		1.45	1.70
10	1.60	1.55	1.42		1.45	1.65
11	1.60	1.55	1.40		1.45	1.65
12	1.60	1.55	1.40		1.45	1.65
13	1.60	1.48	1.40		1.45	1.70
14	1.55	1.45	1.40		1.45	1.70
15	1.50	1.40	1.40		1.45	1.65
16	1.50	1.40	1.40		1.45	1.65
17	1.50	1.40	1.40	1.45	1.45	1.65
18	1.50	1.40	1.40	1.45	1.45	1.65
19	1.52	1.40	1.40	1.45	1.45	1.70
20	1.55	1.40	1.40	1.45	1.45	1.65
21	1.52	1.62	1.40	1.45	1.50	1.70
22	1.50	1.50	1.40	1.45	1.50	1.75
23	1.50	1.48	1.40	1.45	1.50	1.70
24	1.50	1.45	1.40	1.45	1.55	1.60
25	1.50	1.45	1.40	1.45	1.60	1.65
26	1.50	1.45	1.40	1.45	1.65	1.65
27	1.55	1.45	1.40	1.45	1.70	1.65
28	1.70	1.45	1.40	1.45	1.75	1.70
29	1.70	1.48	1.40	1.45	1.75	1.65
30	1.70	1.45	1.40	1.45	1.75	1.65
31	1.70	1.45		1.45		1.65

a No gage readings October 1-16.

Mean daily gage height, in feet, of Phillips Lake, at East Holden, Me., for 1904.

Day.	July.	Aug.	Oct.	Dec.	Day.	July.	Aug.	Oct.	Dec.
6		6.50		8.30	19	7.05			
14		6.37			21		6.62		
17			7.34		22		6.70		
18		6.40			31	6.70			

KENNEBEC RIVER DRAINAGE BASIN.

nnebec River is one of the best streams in the United States for evelopment of water power. Its basin, which lies wholly within tate of Maine, between those of the Androscoggin and the Penob- is 150 miles in length and from 50 to 80 miles in width in the portion, embracing a total area of 6,110 square miles. Of this 1,330 square miles are tributary to Moosehead Lake, in which iver has its source. The upper tributaries, however, rise in the , forested areas lying to the east and west of that lake. Of these, e River is the most important. The northern part of the drain- asin is broken by offsets from the White Mountains. Nearly the e of the upper portion is forest covered and in its original wild

low the outlet of Moosehead Lake the hills close in upon the , forming a narrow, rocky chasm, with steep and precipitous . From Moosehead Lake to The Forks the river is a torrent, otal fall in the 23 miles being 500 feet. Dead River is tributary e Kennebec at The Forks. Below this junction the river flows a lesser slope in a narrow, winding bed about 20 miles to Bing- thence through a broader valley in which are located many s. There are between Bingham and tide water a number of large at which water power has been developed.

e prevailing rock in the northern part of the basin is slate, with t of sandstone to the west and a district of granite to the east of ehead. South of Bingham mica-schists run into the clay slate ots and elsewhere into gneiss, but (except where broken by sions of granite, as at Hallowell and Augusta) slate prevails r as Gardiner. Below the latter city gneiss predominates, with ches of mica-schists on the east bank. The surface materials are pulverized. Water-retaining sands and gravels are more abun- in the northern part, succeeded by a greater proportion of loam lay to the south.

e areas of the drainage basins of the river and its principal trib- ies are given in the following table.

Drainage areas of Kennebec River and principal tributaries.

River.	Locality.	Draina area
		Square
Kennebec	Outlet of Moosehead Lake	1,
Do	The Forks	1,
Do	Immediately below mouth of Dead River	2,
Do	Caratunk Falls, Solon	2,
Do	North Anson, above mouth of Carrabassett River.	2,
Do	Madison	3.
Do	Norridgewock	4.
Do	Fairfield	4.
Do	Waterville, above mouth of Sebasticook River.	4.
Do	Waterville, below mouth of Sebasticook River.	5.
Do	Augusta	5.
Do	Head of Merrymeeting Bay	6.
Moose	Mouth	
Roach	Roach River	
Dead	Mouth, The Forks	
Carrabassett	North Anson, above Embden Brook	
Do	Mouth	
Sandy	Farmington	
Do	Mouth	
Sebasticook	do	
Messalonskee	do	
Cobbosseecontee	do	

The United States Geological Survey now maintains gaging stati at the following places in the Kennebec drainage: On the Kenne at The Forks and at North Anson; on Moose River at Rockwood; Roach River at Roach River; on Dead River at The Forks; on Ca bassett River at North Anson; on Sandy River near Madison; on M salonskee River at Waterville.

In addition, figures of flow are furnished the Survey by priv parties for Kennebec River at Waterville, and Cobbossecontee Ri at Gardiner.

KENNEBEC RIVER AT THE FORKS, ME.

This station was established by N. C. Grover, September 28, 19 at the wooden highway bridge across Kennebec River at The Fo above the mouth of Dead River. The drainage area at the statio 1,670 square miles. Of this area 1,330 square miles are tributar

Moosehead Lake, while the remaining 340 square miles are drained into the Kennebec by small streams with steep slopes and no storage. Practically all land surfaces above this point are in forest. There are two gages—one, a vertical rod, is attached to the timber retaining wall on the left bank about 75 feet above the bridge; the other is of the standard chain type, and is attached to the bridge floor; length of chain, 17.18 feet. The datum of the two gages is the same and is referred to two bench marks; (1) the top of a bolt on the east abutment, north side of bridge; elevation, 12.85 feet above gage datum; (2) marked point on the floor of the bridge near the east end of the gage box; elevation, 15.42 feet above gage datum; gage datum is at elevation 562.85 feet above mean sea level, as determined by the Kennebec River survey of 1904. The initial point of soundings is on the left bank, marked by a rod across the bridge, just above the abutment and below the bridge floor. The channel is straight above the station for about 200 feet and below for a distance of 500 feet, is unbroken by piers, and is about 125 feet wide at ordinary stages of the river. The current is swift; observed mean velocities ranged from 7.67 feet per second at gage height, 5.60 to 0.86 of a foot per second at gage height 0.90. The banks are high and rocky and the bed is rocky and permanent. The gage is read twice daily by William W. Young.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Kennebec River at The Forks, Me., 1901–1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1901.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
September 28	N. C. Grover	774	2.40	2.60	1,860
October 20	do	550	.86	.90	473
1902.					
April 25	N. C. Grover	930	3.76	3.70	3,500
June 16	do	1,160	7.64	5.60	8,860
June 25	do	1,050	5.61	4.75	5,900
September 29	F. E. Pressey	730	2.03	2.10	1,480
1903.					
August 18	N. C. Grover	979	4.27	3.95	4,180
November 4	do	614	1.23	1.26	757
November 4	do	614	1.24	1.26	759
1904.					
July 27	H. K. Barrows	650	1.63	1.70	1,060
August 29	do	863	3.15	3.12	2,720

Mean daily gage height, in feet, of Kennebec River at The Forks, Me., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	2.30	[a]2.40	2.00	4.85	5.75	4.10	2.25	3.05	2.60	1.45	2.10
2	[b]1.90	.....	.....	.....	4.25	5.65	4.20	2.40	3.10	2.35	1.40	2.10
3	.....	.....	.....	1.50	3.70	6.25	4.75	3.70	3.60	2.05	1.40	2.10
4	.....	[c]2.30	.....	.80	3.50	5.90	4.60	3.25	4.10	1.85	1.40	[d]2.50
5	.....	.....	.....	.80	3.40	6.30	4.40	3.30	4.05	1.95	1.55	[e]2.40
6	.....	.....	.....	.90	3.40	5.90	4.10	3.25	3.85	1.50	1.70	[e]2.40
7	[a]2.00	.....	[a]2.20	1.10	3.30	6.40	4.15	3.15	3.30	1.35	2.50	[f]2.60
8	.....	.....	2.40	[g]1.20	3.30	4.75	3.95	3.10	3.05	1.30	2.65	[h]2.70
9	[a]1.90	.....	2.50	[g]6.80	3.20	5.35	4.00	3.05	2.90	1.30	2.15	[i]2.80
10	.....	.....	[a]2.50	[g]2.60	3.70	5.10	4.05	3.35	2.80	1.60	2.10	[h]3.10
11	.....	[c]2.60	.....	[g]3.20	5.30	6.10	4.30	3.25	2.70	2.30	1.95	[i]3.20
12	[c]1.90	[j]2.60	[a]2.30	[g]3.70	4.80	6.30	4.85	3.65	2.60	2.85	2.00	3.30
13	1.90	[j]2.60	.....	2.80	4.00	7.00	5.25	3.55	2.60	3.05	2.15	3.30
14	2.10	.....	.....	2.80	3.20	6.90	5.30	3.75	2.65	3.10	2.30	3.50
15	.....	2.60	.....	3.10	4.10	4.20	5.20	3.30	2.95	3.10	2.20	3.50
16	[c]2.00	.....	[a]2.10	3.10	4.30	4.20	6.10	2.10	2.20	3.05	2.30	3.80
17	.....	.....	.....	2.90	4.65	4.45	5.50	3.90	1.90	3.00	2.20	3.80
18	.....	[c]2.40	.....	1.80	4.80	3.90	4.40	3.35	1.80	2.65	2.20	4.00
19	[c]2.00	.....	2.30	2.10	5.65	3.90	4.15	3.50	1.70	2.40	2.15	4.10
20	.....	2.40	[j]2.40	1.70	5.30	[k]7.50	4.10	3.40	1.50	2.30	2.10	4.10
21	[c]2.00	.....	2.40	1.70	4.90	.....	4.00	2.35	1.50	2.25	2.15	4.20
22	[c]2.00	.....	.....	1.80	3.10	[k]4.60	5.85	2.30	1.70	2.55	2.10	4.40
23	.....	.....	.....	1.90	5.25	[k]3.85	2.15	1.50	1.75	2.30	2.05	4.20
24	.....	.....	2.40	2.65	4.25	[k]3.85	6.10	1.75	2.00	2.05	2.05	4.40
25	[c]2.30	.....	2.40	3.35	5.60	[k]3.90	4.20	2.00	2.60	2.40	2.00	4.60
26	.....	.....	2.40	3.20	4.50	4.35	3.60	2.25	2.60	2.25	2.00	4.60
27	.....	[c]2.40	2.40	3.25	4.55	4.35	3.50	2.55	2.55	2.00	2.05	4.60
28	[c]2.30	.....	2.30	3.30	4.45	4.30	3.40	3.10	2.70	1.70	2.00	4.80
29	[c]2.40	.....	2.30	3.40	5.50	4.10	3.70	3.20	2.55	1.80	2.00	4.50
30	.....	.....	2.10	3.95	5.55	4.00	3.40	3.10	2.70	1.55	2.10	4.80
31	.....	.....	2.20	.....	5.25	.....	3.05	3.10	.....	1.50	.....	4.70

[a] Ice 2.2 feet thick. [b] Ice 1.4 feet thick. [c] Ice 2 feet thick.

Anchor ice caused backwater effect on gage estimated as follows:

[d] 0.4 foot.
[e] 0.3 foot.
[f] 0.5 foot.
[g] Ice from Dead River formed a jam a short distance below gage and caused backwater.
[h] 0.6 foot.
[i] 0.7 foot.
[j] Ice 2.1 feet thick.
[k] Log jam formed short distance below gage caused estimated backwater effect on gage of 0.3 foot.

NOTE.—During frozen season gage readings are to surface of water in hole cut in ice.

Rating table for Kennebec River at The Forks, Me., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.9	480	1.6	1,040	2.7	2,000	4.4	5,020
.95	520	1.7	1,120	2.8	2,105	4.6	5,510
1.0	560	1.8	1,200	2.9	2,220	4.8	6,040
1.05	600	1.9	1,285	3.0	2,350	5.0	6,620
1.1	640	2.0	1,365	3.1	2,490	5.2	7,280
1.15	680	2.1	1,445	3.2	2,635	5.4	8,010
1.2	720	2.2	1,525	3.4	2,950	5.6	8,780
1.25	760	2.3	1,610	3.6	3,310	5.8	9,620
1.3	800	2.4	1,700	3.8	3,700	6.0	10,510
1.4	880	2.5	1,800	4.0	4,120		
1.5	960	2.6	1,900	4.2	4,560		

The foregoing table is applicable only for open-channel conditions. It is based upon 11 discharge measurements made during 1901 to 1904, inclusive. It is well defined between gage heights 1 foot and 5 feet. Above 6 feet gage height the discharges are estimated by logarithmic extension of the discharge curve.

Estimated monthly discharge of Kennebec River at The Forks, Me., for 1904.

[Drainage area, 1,670 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April (10–30)	4,015	1,120	2,226	1.33	1.04
May	8,780	2,635	5,255	3.15	3.63
June	18,090	3,805	8,001	4.79	5.34
July	10,960	1,485	5,232	3.13	3.61
August	3,910	960	2,440	1.46	1.68
September	4,330	960	2,078	1.24	1.38
October	2,490	800	1,565	.937	1.08
November	1,950	880	1,377	.825	.920

KENNEBEC RIVER NEAR NORTH ANSON, ME.

This station was established on October 18, 1901, by N. C. Grover. It is located 1½ miles east of North Anson, above the mouth of Carrabassett River. The drainage area at this point is 2,880 square miles. Measurements are made from the wooden highway bridge across the Kennebec, known locally as Patterson Bridge. There are three gages: One is a vertical rod fastened to the bridge pier; another, for high-water observations, is a vertical rod attached to the right abutment; the third is a low-water gage of the standard chain type, and is attached to the wooden truss on the upstream side of the bridge; length of chain, 30.40 feet when gage was established, but changed to 30.36 feet, July 26, 1904, owing to settlement of bridge. Gage datum is elevated 241.24 feet above mean sea level, as determined by the Kennebec River survey of 1904. The datum of the three gages is the same and is referred to four bench marks: (1) Top of pier back of the gage; elevation, 22.50 feet. (2) Top of the southeast corner of the twelfth stone from the top of west abutment; elevation, 9.55 feet. (3) Copper bolt in bowlder on right bank about 100 feet above the bridge; elevation, 10.66 feet. (4) Marked point on the bottom chord of the bridge near the chain gage; elevation, 25.15 feet originally; changed to 25.03, July 26, 1904. The initial point for soundings is on the left bank at the outside of the end post of the center truss of the bridge. The channel is straight above the station for 500 feet and below for 1,000 feet and has a width of about 350 feet, broken by one pier The current is

moderately rapid, except near the left bank; observed mean velocities at the station have ranged from 3.65 feet per second at gage height 6.80 feet to 1.40 feet per second at gage height 2.85. Low-water measurements are made from a boat about 1,000 feet below the station at a section where there is a better distribution of current. The right bank is high and rocky, while the left bank is comparatively low and subject to overflow at the time of highest water. The bed of the stream is rocky, with sand over a portion of the section, and is permanent. The gage is read twice daily by Mrs. C. S. Benjamin, the toll collector at the bridge.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Kennebec River near North Anson, Me., 1901–1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1901.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
October 14	N. C. Grover	1,540	2.02	3.20	3,120
October 18	do	1,500	1.64	3.00	2,460
1902.					
July 29	F. E. Pressey	2,390	2.60	4.55	6,220
1903.					
March 28	F. E. Pressey	2,900	3.93	6.50	11,400
May 27	do	1,970	1.59	3.25	3,130
June 15	do	3,050	3.64	6.80	11,100
June 16	do	2,424	2.79	4.90	6,740
June 16	do	2,250	2.48	4.38	5,580
July 17	do	1,920	1.54	3.25	2,960
August 15	do	2,120	1.89	3.78	4,000
September 24	N. C. Grover	1,790	1.40	2.85	2,500
November 6	F. E. Pressey	428	2.83	2.00	[a] 1,200
1904.					
January 27	F. E. Pressey	393	1.90	[b] 3.40	74
January 28	do	398	1.97	[b] 3.40	78
March 2	do	285	1.86	[c] 3.55	52
March 4	do	285	2.01	[c] 3.65	57
June 10	do	2,770	3.09	6.00	8,560
July 26	H. K. Barrows	1,780	1.35	2.94	2,400
August 30	do	1,940	1.65	3.43	3,210

[a] Different section.
[b] River frozen. Gage height to water surface. Ice 2.2 feet thick.
[c] River frozen. Gage height to water surface. Ice 2.5 feet thick.

lean daily gage height, in feet, of Kennebec River near North Anson, Me., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	.....	[a] 3.60	[b] 4.80	9.65	6.00	4.30	5.00	3.40	5.70	3.05	[c] 6.05
.....	3.70	.....	[a] 3.60	4.90	8.65	6.00	4.55	4.50	3.40	5.05	2.95	.....
.....	.....	.....	[a] 3.60	4.90	8.70	5.20	4.90	4.20	3.65	4.55	2.75	.....
.....	.....	.....	[a] 3.60	4.90	7.75	5.20	4.75	4.40	4.20	3.95	2.75	.....
.....	.....	.....	[a] 3.60	4.90	7.25	5.70	4.50	4.70	4.65	3.80	2.75	.....
.....	.....	[d] 3.50	.....	5.00	7.40	6.05	4.30	4.80	4.25	3.40	2.80	[e] 5.00
.....	.....	.....	.....	5.15	7.15	7.40	4.25	4.10	4.00	3.15	3.15	.....
.....	.....	.....	.....	5.50	6.05	6.90	4.10	4.50	3.80	3.00	3.45	.....
.....	[f] 3.50	.....	.....	5.75	6.70	6.35	4.05	3.60	3.60	2.95	3.35	.....
.....	.....	.....	.....	[g] 6.85	9.10	6.60	3.95	3.45	3.45	2.95	3.15	.....
.....	.....	.....	[h] 4.00	8.45	8.50	6.45	3.95	3.25	3.15	3.15	3.20	.....
.....	.....	.....	[i] 4.40	10.10	10.70	5.85	5.00	3.30	3.20	3.35	3.20	.....
.....	.....	[f] 3.20	.....	8.60	8.35	5.60	5.60	3.90	3.15	3.70	3.15	.....
.....	.....	.....	.....	6.80	7.00	5.35	5.35	3.50	3.15	3.80	3.30	.....
.....	.....	.....	.....	5.00	6.10	5.05	5.10	3.40	3.45	3.75	3.15	.....
.....	[f] 3.40	.....	.....	4.90	9.90	5.05	5.10	3.95	3.95	3.75	3.15	[j] 4.00
.....	.....	.....	.....	4.40	9.95	4.80	4.80	4.90	3.90	3.90	3.15	.....
.....	.....	.....	.....	4.00	8.15	4.50	4.80	4.50	3.40	3.75	3.15	.....
.....	.....	.....	[k] 4.20	3.65	7.35	4.50	4.80	3.65	3.20	3.30	3.05	.....
.....	.....	[f] 3.50	.....	4.25	7.35	4.60	3.85	3.85	3.00	3.25	2.95	.....
.....	.....	.....	.....	4.10	6.35	4.95	4.00	4.20	2.90	3.20	3.00	.....
.....	.....	.....	.....	3.80	6.80	4.60	3.05	3.70	3.05	4.70	3.40	.....
.....	[b] 3.20	.....	.....	4.15	6.40	4.80	3.05	3.80	3.00	4.80	3.20	.....
.....	.....	.....	.....	4.80	5.90	4.25	3.40	3.00	3.05	4.55	3.25	[l] 3.80
.....	.....	.....	.....	5.60	5.55	4.10	3.55	3.00	3.30	4.20	3.15	.....
.....	.....	.....	[m] 4.40	5.90	5.90	4.30	3.25	2.85	3.80	3.75	3.20	.....
.....	[m] 3.40	[f] 3.70	.....	6.00	5.85	4.35	3.65	2.95	3.80	4.15	3.20	.....
.....	[m] 3.40	.....	.....	6.15	5.45	4.40	4.15	3.25	3.80	4.20	3.55	.....
.....	.....	.....	.....	7.05	6.20	4.30	3.90	3.50	4.00	3.50	5.10	.....
.....	[b] 3.20	.....	.....	8.95	6.30	4.20	3.95	3.40	5.10	3.30	5.75	.....
.....	.....	.....	.....	.....	5.90	.....	3.95	3.40	.....	3.20	.....	[n] 5.00

[a] Ice 2.5 feet thick.
[b] Ice 2 feet thick.
[c] River frozen over.
[d] Ice 1.9 feet thick.
[e] Ice 0.35 foot thick.
[f] Ice 1.85 feet thick.
[g] River clear of ice.
[h] Ice 2.8 feet thick.
[i] Ice 2.4 feet thick.
[j] Ice 0.6 foot thick.
[k] Ice 2.7 feet thick.
[l] Ice 0.9 foot thick; gage reading to top of ice = 3.8.
[m] Ice 2.2 feet thick.
[n] Ice 1.8 feet thick; gage reading to top of ice = 5.0.

NOTE.—During frozen season gage readings are to surface of water in hole cut in ice.

Rating table of Kennebec River near North Anson, Me., from January 1 to Dec 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Dischar
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-*
2.75	2,150	4.0	4,587	5.5	8,360	7.0	12,6
2.8	2,224	4.1	4,825	5.6	8,630	7.2	13,3
2.85	2,302	4.2	5,065	5.7	8,900	7.4	13,9
2.9	2,384	4.3	5,305	5.8	9,170	7.6	14,5
2.95	2,468	4.4	5,545	5.9	9,450	7.8	15,1
3.0	2,554	4.5	5,785	6.0	9,730	8.0	15,7
3.1	2,729	4.6	6,035	6.1	10,020	8.2	16,4
3.2	2,908	4.7	6,285	6.2	10,310	8.4	17,0
3.3	3,091	4.8	6,535	6.3	10,600	8.6	17,7
3.4	3,281	4.9	6,790	6.4	10,890	8.8	18,3
3.5	3,479	5.0	7,050	6.5	11,180	9.0	18,9
3.6	3,685	5.1	7,310	6.6	11,480	9.5	20,6
3.7	3,899	5.2	7,570	6.7	11,780	10.0	22,2
3.8	4,121	5.3	7,830	6.8	12,080	10.5	23,9
3.9	4,351	5.4	8,090	6.9	12,380		

The above table is applicable only for open-channel conditions. It is base 13 discharge measurements made during 1901 to 1904, inclusive. It is fairl defined between gage heights 2 feet and 5 feet. Above gage height 5 feet the is somewhat uncertain. The table has been extended beyond these limits.

Estimated monthly discharge of Kennebec River near North Anson, Me., for 19

[Drainage area, 2,880 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	D i
April 10–30	22,620	3,791	9,755	3.39	
May	24,660	8,225	13,940	4.84	
June	13,920	4,825	7,783	2.70	
July	8,630	2,641	5,250	1.82	
August	7,050	2,302	4,265	1.48	
September	7,310	2,384	3,747	1.30	
October	8,900	2,462	4,221	1.47	
November	9,035	2,150	3,146	1.09	

KENNEBEC RIVER AT WATERVILLE, ME.

The only long-continued observations of the flow of the riv those which have been made at Waterville by the Hollingswo Whitney Company, which kindly furnishes the results for public

rks of that company are above the mouth of Sebasticook River. butary drainage area of the Kennebec at that point is about quare miles. Observations are made at 12 o'clock noon of each at hour having been chosen, after investigation, as a time when v is least affected by storage at dams upstream and as giving early the average for the day.

n the flow of the river is less than 3,500 second-feet, the whole : is diverted through the water wheels of the mill, of which re 48. Water in excess of the above amount is wasted over the All of the wheels have been tested at Holyoke under practically ie head as used at Waterville. Discharge curves for the wheels · overflow of the dam, both with and without flashboards, were icted several years ago by Mr. Sumner Hollingsworth. Esti- of daily flow are made by means of these diagrams. The ; through the crib dam has never been measured, but 100 ·feet are added arbitrarily to cover this item.

daily discharge, in second-feet, of Kennebec River at Waterville, Me., for 1904.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1,313	953	1,018	8,733	34,770	7,532	6,131	5,080	3,514	10,460	4,148	2,903
975	918	1,047	7,980	33,910	10,490	5,980	5,168	3,692	7,968	3,908	2,891
1,381	917	1,044	6,770	23,890	10,220	4,872	4,086	3,415	6,806	3,649	3,462
714	944	1,132	7,211	22,060	8,675	4,140	4,983	3,602	5,960	3,521	1,545
896	1,248	1,370	6,777	20,730	10,310	7,370	4,923	5,534	4,183	3,516	3,150
552	940	100	8,349	21,970	10,610	6,174	4,508	5,921	4,064	2,689	2,894
959	543	659	9,541	18,370	12,740	5,585	3,843	5,458	4,305	3,494	2,783
956	940	2,063	15,620	13,390	14,460	5,428	4,817	5,170	3,875	3,486	2,764
1,545	629	2,616	23,240	12,810	11,250	5,628	4,378	3,597	3,959	3,573	2,859
100	654	2,982	33,340	25,760	13,250	3,423	3,943	4,050	4,045	3,793	2,895
830	1,891	3,552	33,530	30,910	12,000	5,442	4,556	2,610	3,828	3,223	100
1,218	615	3,291	27,600	37,840	11,190	5,590	4,970	3,779	4,116	3,764	3,183
916	713	3,033	23,080	26,850	7,402	7,049	6,273	3,779	4,027	2,659	2,302
1,909	100	3,254	14,620	19,610	6,051	8,263	5,247	3,176	4,284	4,096	2,459
1,163	645	3,232	12,310	15,510	5,919	6,969	5,687	3,777	4,159	3,512	2,587
1,543	1,389	2,799	10,590	28,760	5,801	6,989	5,326	6,978	3,144	4,071	2,323
100	538	2,736	8,813	37,560	5,552	3,694	5,087	5,822	4,350	4,365	2,596
912	1,432	2,513	8,343	27,440	6,388	5,512	5,419	4,531	4,464	2,875	1,249
1,577	578	2,097	7,947	20,680	4,670	5,774	4,918	4,030	4,121	2,898	3,163
905	1,393	1,413	8,414	24,520	6,458	4,346	4,261	4,055	4,062	2,678	3,178
1,764	100	2,426	10,530	20,910	6,401	4,969	4,380	2,961	3,322	3,755	2,771
900	1,031	2,497	10,460	17,880	6,324	4,692	6,720	3,767	5,179	4,078	3,423
910	908	3,078	11,110	15,150	5,979	2,941	5,280	4,004	6,866	4,053	2,775
303	1,329	3,372	11,740	14,530	5,834	3,987	4,537	3,722	5,722	658	2,899
1,012	987	4,064	15,180	13,970	5,579	4,998	3,913	2,691	4,214	4,105	1,966
995	1,295	10,470	16,320	13,010	5,110	4,805	4,112	4,082	4,146	2,407	2,074
1,642	1,420	11,080	17,810	11,120	7,848	4,699	3,535	4,042	4,816	3,465	3,127
638	100	11,380	15,930	11,200	7,251	4,933	2,950	4,381	4,516	2,962	2,833
634	651	10,400	20,910	8,277	11,860	5,619	4,256	4,251	3,964	2,353	2,474
629	.....	8,449	36,110	9,031	5,423	5,523	4,152	8,111	2,768	.....	3,048
348	.....	8,189	.....	9,774	.....	4,550	4,534	.....	4,139	.....	2,764

MOOSE RIVER NEAR ROCKWOOD, ME.

This station was established September 7, 1902, by N. C. Grover. It is located 4 miles west of Kineo, Me., and 2 miles from the mouth of the river. The drainage basin is 680 square miles at this point. Water is stored by dams at the outlets of several of the lakes and ponds in the basin above, but all of such stored water is used for log driving. The stage of the river changes very slowly after the end of the log-driving season. Practically all of the land areas in this basin are in forest. Measurements are made from a car suspended from a steel cable, or by wading at low water. The initial point for soundings is on the right bank, 1 foot from a birch tree, to which the tag line and cable are attached. There are two gages: One is a painted post driven into the clay bed of the river and braced from several trees; the other is a standard chain gage attached to trees on the bank. The datum of the two gages is the same, and is referred to bench marks as follows: (1) Copper bolt in bowlder 8 feet from corner of house of Peter Callaghan; elevation, 14.58 feet. (2) Highest point of large bowlder on right bank 150 feet below the cable; elevation, 5.75 feet. The channel is about 220 feet wide at ordinary stages and is straight both above and below the station. The banks are high and rocky; the bed of the stream is rocky and permanent. The gage is read twice daily by Peter Callaghan.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Mean daily gage height, in feet, of Moose River near Rockwood, Me., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.55	4.65	4.00	2.50	2.30	4.70	3.75	2.7
2	.....	6.90	4.60	3.95	2.50	2.35	5.05	3.70	2.6
3	.....	7.15	4.55	4.10	2.50	2.40	5.10	3.60	2.5
4	.....	7.10	4.25	4.20	2.50	2.55	5.10	3.60	2.5
5	.....	7.30	4.25	4.10	2.40	2.85	5.05	3.50	2.5
6	.....	7.55	4.55	4.00	2.30	3.05	5.00	3.50	2.5
7	.....	7.40	4.70	3.85	2.30	3.10	4.90	3.40	2.5
8	.....	7.30	4.95	3.75	2.20	3.10	4.80	3.40	2.4
9	.....	7.25	5.05	3.60	2.20	3.05	4.65	3.30	2.3
10	1.80	7.35	5.00	3.50	2.15	3.00	4.60	3.20	2.3
11	3.15	8.00	5.05	3.45	2.20	3.00	4.50	3.15	.....
12	3.45	9.05	5.25	3.35	2.30	2.95	4.40	3.10	.....
13	3.70	9.10	5.05	3.40	2.30	2.90	4.40	3.10	.....
14	3.85	8.70	4.80	3.35	2.40	2.90	4.35	3.10	.....
15	4.00	8.10	4.65	3.30	2.50	2.95	4.25	3.10	.....
16	4.10	7.90	4.45	3.20	2.50	3.20	4.15	3.10	.....
17	4.15	7.90	4.25	3.15	2.50	3.45	4.05	3.00	.....
18	4.20	7.65	4.10	3.00	2.40	3.50	4.00	2.90	.....
19	4.20	7.25	4.10	2.90	2.40	3.70	3.90	2.90	.....
20	4.20	7.05	.....	2.70	2.45	3.70	3.80	2.90	.....
21	4.30	6.85	.....	2.60	2.50	3.75	3.80	2.90	.....
22	4.30	6.60	.....	2.50	2.65	3.80	3.90	2.90	.....
23	4.30	6.50	4.65	2.40	2.70	3.80	4.00	2.90	.....
24	4.50	6.30	4.65	2.40	2.70	3.80	4.10	2.80	.....
25	4.75	6.00	4.70	2.40	2.70	3.95	4.00	2.80	.....
26	5.05	5.65	4.60	2.40	2.70	4.05	4.00	2.80	.....
27	5.30	5.45	4.55	2.45	2.60	4.20	4.00	2.80	.....
28	5.55	5.30	4.55	2.50	2.50	4.30	3.90	2.80	.....
29	5.85	5.05	4.60	2.50	2.50	4.30	3.90	2.70	.....
30	6.20	5.05	4.20	2.50	2.45	4.50	3.80	2.70	.....
31	.....	4.95	.....	2.50	2.40	.....	3.80	.....	.....

ROACH RIVER AT ROACH RIVER, ME.

ream, which has a total drainage area of 120 square miles, oosehead Lake from the east. Its basin is completely for- ams at the outlets of several ponds control the flow of the he gage is located at about 100 feet downstream from the these dams, at which point the river is so completely under hat the stage does not vary perceptibly for weeks at a time. ed water is used for log driving.

ation was established November 10, 1901, by N. C. Grover. age area at this point is 85 square miles. The gage is a ver- spiked to the timber retaining wall on the right bank of the It is referred to a bench mark, which is a cross cut in the high- r of the crib to which the gage is spiked; elevation, 9 feet. asurements of flow are made by wading, or from a boat at a out 2,000 feet downstream from the gage. The bed of the this point is rocky and permanent. The channel is straight t 60 feet wide. The gage is read twice daily by C. H. Sawyer. servations at this station during 1904 have been made under ion of H. K. Barrows, district hydrographer.

daily gage height, in feet, of Roach River at Roach River, Me., for 1904.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(a)	(a)	(a)	2.30	4.80	2.30	2.30	2.20	2.20	2.30	2.30	2.10
.....	.....	.....	2.30	5.30	5.50	2.30	2.20	2.20	2.30	2.20	2.10
.....	.....	.....	2.30	5.55	5.50	2.30	2.20	2.20	2.30	2.10	2.10
.....	.....	.....	2.30	5.40	5.50	2.30	2.20	2.60	2.30	2.10	(b)
.....	.....	.....	2.30	5.40	5.50	2.30	2.20	2.25	2.30	2.10	.....
.....	.....	.....	2.30	5.40	5.50	2.30	4.00	2.30	2.30	2.10	.....
.....	.....	.....	2.30	5.40	5.50	2.30	3.80	2.30	2.30	2.10	.....
.....	.....	.....	2.30	5.40	5.50	2.30	3.00	2.55	2.30	2.10	.....
.....	.....	.....	2.30	2.30	3.30	2.30	3.00	2.80	2.30	2.10	.....
.....	.....	.....	2.30	2.30	3.30	2.30	3.00	2.80	2.30	2.10	.....
.....	.....	.....	2.30	2.30	3.30	2.30	2.60	2.30	2.30	2.10	.....
.....	.....	.....	2.30	5.40	3.30	2.30	2.60	2.30	2.30	2.10	.....
.....	.....	.....	2.30	5.40	2.50	2.30	3.40	2.30	2.30	2.10	.....
.....	.....	.....	2.30	2.30	2.50	2.30	3.40	2.30	2.30	2.10	.....
.....	.....	.....	2.30	2.30	2.50	2.30	3.40	2.30	2.30	2.10	.....
.....	.....	.....	2,30	2.30	2.50	2.30	2.85	2.30	2.30	2.10	.....
.....	.....	.....	2.20	5.50	2.30	2.30	2.30	2.30	2.30	2.10	.....
.....	.....	.....	2.20	5.50	2.30	2.60	2.30	2.30	2.30	2.10	.....
.....	.....	.....	2.20	2.30	2.30	2.60	2.30	2.30	2.30	2.10	.....
.....	.....	.....	2.20	2.30	2.30	2.60	2.30	2.30	2.30	2.10	.....
.....	.....	.....	2.20	5.50	2.30	2.60	2.30	2.30	2.55	2.10	.....
.....	.....	.....	2.20	5.50	2.30	3.00	2.30	2.30	2.30	2.10	.....
.....	.....	.....	2.20	2.30	2.30	2.60	2.70	2.30	2.65	2.10	.....
.....	.....	.....	2.20	3.90	2.30	2.20	2.70	2.30	3.00	2.10	.....
.....	.....	.....	2.20	3.90	2.30	2.20	2.20	2.30	3.00	2.10	.....
.....	.....	2.30	2.20	5.50	2.30	2.20	2.20	2.30	3.00	2.10	.....
.....	.....	2.30	2.20	2.30	2.30	2.20	2.20	2.30	3.40	2.10	.....
.....	.....	2.30	2.20	5.50	2.30	2.20	2.60	2.30	3.40	2.10	.....
.....	.....	2.30	3.30	2.30	2.30	2.20	2.20	2.30	3.40	2.10	.....
.....	.....	2.30	4.20	5.50	2.30	2.20	2.20	2.30	3.00	2.10	.....
.....	.....	2.30	.....	5.50	.....	2.20	2.20	.....	3.00	.....	.....

a River frozen January 1 to March 25.
b River frozen December 4-31, inclusive.

DEAD RIVER NEAR THE FORKS, ME.

This tributary of the Kennebec has its headwaters in the mountains between Maine and Canada, and flows in a general easterly direction, entering the Kennebec at The Forks. Its basin contains 870 square miles and is 40 miles in extreme length by 30 miles in width, and is almost entirely covered with forests. Through a large portion of its length the river flows through swamps; in its lower course it has considerable fall. The only dams on the stream are owned by the log-driving companies, and the gates are kept open after the drives are out of the river.

This gaging station was established by N. C. Grover on September 29, 1901. It is located 1½ miles west of The Forks. The measurements are made from a car suspended from a steel cable. The gage is a vertical rod attached to a large bowlder on the left bank about 700 feet below the cable. It is referred to a bench mark, a copper bolt set in a bowlder 9.5 feet from the gage; elevation, 7.97 feet above zero of the gage. The channel is straight for 500 feet above and below the cable, and is about 225 feet wide at ordinary stages. The banks are rocky and are subject to overflow in extreme freshets. The bed is rocky and permanent. The current is rapid; the lowest observed mean velocity is 0.65 of a foot per second at gage height 0.69. The gage is read twice daily by Jeremiah Durgin, jr., a farmer at The Forks.

The observations at this station during 1904 have been made under the direction of H. K. Barrow, district hydrographer.

Discharge measurements of Dead River near The Forks, Me., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 8	F. E. Pressey	900	3.86	3.00	3,470
June 9	do	1,780	8.57	6.35	15,300
June 21	do	444	1.48	1.05	655
June 21	do	453	1.49	1.05	676
July 27	H. K. Barrows	349	.80	.72	279
August 29	do	376	.98	.78	370

n daily gage height, in feet, of Dead River near The Forks, Me., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	4.15	2.25	1.05	0.95	0.75	2.15	1.35	0.95
.....	.....	4.90	2.45	1.20	.95	.75	3.05	1.35	.95
.....	.....	5.35	4.15	1.45	.85	.75	3.00	1.35	.95
.....	.....	5.40	3.45	1.70	.85	.85	2.70	1.25	1.05
.....	4.95	6.85	2.45	1.55	.80	1.25	2.60	1.20	1.05
.....	.....	5.25	4.65	1.40	.75	1.45	2.55	1.15	1.15
.....	.....	4.55	3.45	1.25	.75	1.30	2.25	1.15	1.15
.....	.....	4.45	4.65	1.20	.65	1.20	1.70	1.25	1.15
.....	(a)	4.15	4.75	1.00	.65	1.05	1.40	1.25	1.25
.....	2.85	4.75	4.50	1.00	.65	1.05	1.35	1.25	1.40
.....	2.05	5.15	3.75	1.10	.75	.95	1.25	1.20	(b)
.....	3.25	4.55	3.45	1.40	.75	.95	1.25	1.15	.....
.....	3.35	4.25	2.60	1.50	.85	1.05	1.15	1.15	.....
.....	3.35	4.05	2.10	1.50	.95	1.25	1.25	1.15	.....
.....	2.35	5.60	1.80	1.30	.95	1.60	1.15	1.05	.....
.....	2.20	4.30	1.50	1.15	.85	1.80	1.15	1.05	.....
.....	1.95	4.60	1.40	1.00	.85	1.70	1.25	1.15	.....
.....	1.80	4.15	1.20	1.05	.85	1.50	1.15	1.15	.....
.....	1.85	6.15	1.05	.95	.85	1.35	1.15	1.05	.....
.....	1.85	5.55	1.05	.95	.75	1.45	1.15	1.05	.....
.....	1.85	5.65	1.05	.95	1.15	1.35	1.70	1.05	.....
.....	1.95	5.45	1.10	.95	1.65	1.35	2.15	1.05	.....
.....	2.05	4.80	1.15	.85	1.70	1.35	2.55	1.05	.....
.....	2.35	4.65	1.20	.85	1.50	1.25	2.75	1.05	.....
.....	2.50	2.85	1.35	.75	1.05	1.25	2.60	1.05	.....
.....	3.30	3.05	1.45	.75	.90	1.40	2.40	1.05	.....
.....	3.00	5.40	1.45	.65	.80	1.60	1.85	.95	.....
.....	3.85	2.90	1.35	.65	.75	1.65	1.65	1.00	.....
.....	6.05	4.85	1.20	.75	.75	1.75	1.50	1.00	.....
.....	4.45	2.75	1.10	.85	.75	1.85	1.40	.95	.....
.....	.....	1.95	.....	.95	.75	.....	1.35	.....	.....

er clear of ice April 9.
er frozen over; anchor ice affects gage readings. No readings during frozen period.

CARRABASSETT RIVER AT NORTH ANSON, ME.

river enters the Kennebec from the west at North Anson. Its as steep slopes, partly in farm lands, with no large natural irs. Dams have been constructed and power used at New d, East New Portland, and North Anson.

gaging station was established on October 19, 1901, by N. C. . It is located above Embden Brook and below Anson Brook. ainage area is 340 square miles at this point. Gagings are y wading at low stages or from a boat at high stages of the There are two gages. One is a vertical rod attached to a tree; r is a standard chain gage attached to trees on the bank; length 1, 36.73 feet. The datum of the two gages is the same, and is l to two bench marks: (1) Point on root of a blazed spruce

tree 40 feet from the vertical gage; elevation, 10.78 feet. (2) Copper bolt set in a large bowlder at the outlet of Anson Brook; elevation, 11.40 feet. The channel is straight 500 feet above the station and 300 feet below, and is about 150 feet wide, divided into two parts at low stages of the river by a gravelly bar. The bed is of coarse gravel and permanent. Observed mean velocities range from 3.35 feet per second at gage height 2.68 feet to 0.93 of a foot per second at gage height 0.60 foot. The gage is read once daily by N. Q. Hilton, a farmer at North Anson.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Carrabassett River at North Anson, Me., 1902–1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1902.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 27	N. C. Grover	1,330	3.14	4.30	4,170
July 30	F. E. Pressey	203	.95	.60	192
October 30	do	564	3.21	2.47	1,810
October 30	do	632	3.35	2.67	2,120
October 31	do	458	2.99	1.99	1,370
November 1	do	388	2.91	1.69	1,130
November 2	do	326	2.71	1.42	882
November 1	do	379	2.86	1.60	1,080
November 3	do	314	2.71	1.35	851
1903.					
May 26	N. C. Grover	151	1.38	.45	208
July 17	F. E. Pressey	264	1.33	.90	348
August 15	do	215	1.39	.71	300
September 23	N. C. Grover	42	1.81	.15	76
November 6	F. E. Pressey	94	1.76	.30	165
1904.					
August 30	H. K. Barrows	100	1.54	.40	154

daily gage height, in feet, of Carrabassett River at North Anson, Me., for 1904.

ay.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	.....	7.3	0.9	0.4	0.7	0.3	2.1	1.1	0.8
.....	.....	.....	4.9	.9	.8	.7	.3	1.8	1.1	.8
.....	.....	.....	4.0	.8	1.0	.6	.3	1.4	1.0	1.0
.....	a 1.9	.....	4.2	.8	.9	.5	.5	1.2	1.0	1.1
.....	.....	.....	4.4	.8	.6	.4	.7	1.0	1.0	.9
.....	.....	.....	3.7	1.1	.6	.4	.5	.9	.8	.8
.....	.....	.....	3.8	2.3	.7	.4	.4	.9	.8	1.0
.....	.....	.....	2.6	1.8	.5	.4	.4	.8	.8	.8
.....	.....	.....	2.4	1.5	.4	.4	.3	.8	.7	.7
.....	.....	4.7	9.5	1.3	.3	.4	.3	.8	.8	.7
.....	.....	5.2	5.8	1.1	.3	.6	.3	.7	.8	.7
.....	.....	4.1	4.6	.9	2.3	1.3	.3	.7	.8	.7
.....	.....	3.3	3.5	.8	1.5	1.2	.4	.7	.6	.6
.....	.....	2.7	2.9	.7	1.9	.9	.3	.8	.7	.7
.....	.....	2.2	2.4	.6	1.4	.9	.9	.8	.9	.6
.....	.....	1.9	11.3	.5	1.1	.8	1.9	.8	.8	.7
.....	.....	1.6	6.6	.5	.8	.7	1.3	.7	.7	.7
.....	.....	1.7	4.1	.5	.7	.6	1.0	.7	.8	.6
.....	.....	1.8	3.3	.4	.5	.5	.9	.7	.9	.7
.....	.....	2.8	4.4	.4	.4	.4	.9	.6	.9	.7
.....	.....	2.5	3.1	.3	.4	2.7	.9	.6	.7	.7
.....	.....	2.3	2.5	.3	.3	1.6	.9	.4	1.2	.7
.....	.....	2.5	2.2	.5	.3	1.3	.8	2.5	.9	.8
.....	.....	3.2	2.0	.5	.2	1.0	.7	1.9	.8	.8
.....	.....	3.9	1.7	.4	.3	.8	.5	1.6	.9	.8
.....	.....	3.4	1.6	.6	.3	.7	.4	1.4	1.0	.7
.....	.....	3.7	1.5	.4	.2	.5	.4	1.9	.9	.8
.....	.....	3.4	1.4	.3	.9	.5	.4	1.6	.7	.9
.....	.....	4.7	1.3	.1	1.8	.5	.7	1.5	.8	.9
.....	.....	7.1	1.2	.2	1.4	.4	2.8	1.3	.8	.9
.....	.....	.....	1.0	.....	.9	.4	.....	1.2	.....	.9

reading to water surface in hole cut in ice at gage; otherwise no readings during frozen

Rating table for Carrabassett River at North Anson, Me., from November 1, 190. December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Dischar
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-fe*
0.1	60	1.5	965	2.9	2,325	4.6	4,57
.2	96	1.6	1,050	3.0	2,450	4.8	4,84
.3	135	1.7	1,135	3.1	2,580	5.0	5,11
.4	177	1.8	1,225	3.2	2,710	5.2	5,38
.5	223	1.9	1,315	3.3	2,840	5.4	5,65
.6	272	2.0	1,405	3.4	2,970	5.6	5,92
.7	327	2.1	1,495	3.5	3,100	5.8	6,19
.8	392	2.2	1,585	3.6	3,230	6.0	6,46
.9	464	2.3	1,680	3.7	3,360	6.5	7,14
1.0	542	2.4	1,775	3.8	3,495	7.0	7,81
1.1	625	2.5	1,875	3.9	3,630	8.0	9,16
1.2	710	2.6	1,980	4.0	3,765	9.0	10,51
1.3	795	2.7	2,090	4.2	4,035	10.0	11,86
1.4	880	2.8	2,205	4.4	4,305	11.0	13,21

The above table is applicable only for open-channel conditions. It is based 12 discharged measurements made during 1902 to 1904. It is well defined bet gage heights 0.2 feet and 2.5 feet. Above 2.5 the curve depends on one measure at 4.3 feet. The table has been extended beyond these limits. Above 3.7 fee rating curve is a tangent, the difference being 135 per tenth.

Estimated monthly discharge of Carrabassett River at North Anson, Me., for 190

[Drainage area, 340 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dep inc
April 10–30	7,950	1,050	2,913	8.57	
May	13,690	542	3,574	10.5	1
June	1,680	60	404	1.19	
July	1,680	96	440	1.29	
August	2,090	177	404	1.19	
September	2,205	135	379	1.11	
October	1,875	177	670	1.97	
November	710	272	438	1.29	
December	625	272	384	1.13	

SANDY RIVER NEAR MADISON, ME.

This stream rises near Rangeley Lake, flowing first southeasterly, then in the last third of its course flowing northeasterly into Kennebec River about 2 miles below the village of Madison. It has a total length of about 50 miles, and while there are a few small ponds in its basin, its storage capacity is small, and the flow is quite variable. It resembles very much in this way Carrabassett River—the slopes being usually steep and the fall very rapid throughout the greater part of its course. Comparatively few water-power developments have been made, namely, at New Sharon, Farmington, and at the point described below near Madison.

This station was established March 23, 1904, by F. E. Pressey. It is located at the dam of the Madison Electric Works just over the town line in Stark, but is nearest Madison post-office. The drainage area at this point is about 650 square miles. The dam rests on ledge rock, has a fairly level crest, 341.4 feet in length between vertical abutments. The crest is 1 foot wide on top, sloping from the upstream edge, 4.75 horizontal to 1.25 vertical, while the downstream face of the dam is vertical. The level top is of dressed stone (6-cut), while the remainder is quarry faced, but care has been taken to leave no considerable projection on the approach to the crest. Provision has been made for the installation of flashboards when necessary. The head developed by the dam is about 15 feet, which is used in a power development on the right bank, consisting of a head bay nearly 100 feet long, decreasing in width from 40 to 20 feet at the racks, and one pair of 36-inch McCormick turbines (rated at Holyoke) with complete arrangements for a second pair if found necessary. This plant is owned by the Madison village corporation, and is used for furnishing light and power. The pondage extends back something like 2 miles, but there is no side flowage. When water is more than 3 feet deep on the dam, the crest is increased in length about 87.5 feet by flowing over the wall of the fore bay. The wheels and generators are in operation only during the night, so that the discharge has been based upon a gage height read late in the afternoon just before starting up; and it is believed that the pondage effect has been wholly eliminated in this way.

A plain vertical staff gage was first fastened to the retaining wall of the dam; the elevation of the 100-foot mark at the gage being equal to the elevation of the crest of the masonry dam. This has been superseded, however, by a float gage referred to the same datum and installed through the courtesy and assistance of C. S. Humphreys, C. E., of Madison, engineer in charge. At the same time another float gage

was placed to record the height of water in the tailrace, so that in case it becomes necessary to use the turbines in estimating flow, records of the head on the wheels may be obtained. The gages are referred to the following bench mark: A point inclosed by a circle on the north side of the wing wall, about 22.8 feet from its end at the dam, marked "B. M." Its elevation is 102.98 feet above gage datum. The gages are read twice daily by Marcus W. Moore, electrician at the station.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

MESSALONSKEE RIVER AT WATERVILLE, ME.

This river enters the Kennebec from the west at Waterville. It has a total drainage area of 208 square miles, of which 30 square miles are lake surface. Messalonskee Lake, which is the nearest of these to the mouth of Kennebec River, has a fall of about 210 feet in a distance of 10 miles, which is practically all utilized.

The United States Geological Survey has maintained a gage at the dam of the Chase Manufacturing Company, in Waterville, since June 18, 1903. The drainage area at this point is about 205 square miles. A vertical staff gage is fastened to the wheel pit, just above the dam. The zero of the gage corresponds to the level of the crest of the dam and is referred to a bench mark as follows: Copper bolt in ledge on opposite side of the river from the end of the dam; elevation, 14.51 feet above the crest of the dam. The dam is a new crib, without leakage, and with a good crest. Generally the water is not used for power purposes at night, and the gage is read while the wheels are not running. At other times the amount of water used through the wheels is added to that which flows over the dam. Flashboards are maintained during low stages of the river. The gage is read once a day by Ernest E. Bowie, watchman at the mill.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Mean daily discharge, in second-feet, of Messalonskee River at Waterville, Me., for 1904.

Date.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	408	.....	.....	273	126	105	149	118	118
2	.....	336	.....	.....	314	149	113	118	118	118
3	.....	292	.....	.....	273	134	118	105	113	126
4	.....	360	.....	.....	251	144	96	90	118	77
5	.....	432	.....	.....	229	149	90	96	126	64
6	.....	533	.....	.....	251	157	105	105	105	69
7	.....	559	.....	.....	273	85	113	90	113	64
8	.....	533	.....	408	273	118	118	90	85	59
9	.....	615	.....	383	284	126	118	77	77	77
10	.....	899	.....	314	212	126	126	85	85	90
11	.....	840	.....	292	149	134	77	90	64	64
12	.....	840	.....	336	244	126	77	90	69	77
13	205	870	.....	212	177	134	96	96	85	90
14	360	811	.....	292	251	113	96	90	105	64
15	336	724	.....	251	251	85	118	90	105	64
16	301	642	.....	205	[a] 64	118	218	64	90	77
17	284	559	.....	251	105	126	149	64	90	54
18	251	615	.....	212	134	134	118	69	85	64
19	273	642	.....	183	157	126	105	64	85	54
20	230	642	.....	193	134	134	118	85	90	64
21	260	642	.....	205	200	200	105	64	90	41
22	273	.....	.....	193	185	126	90	134	96	54
23	587	.....	.....	177	157	144	85	200	105	41
24	724	.....	.....	273	134	126	90	134	105	41
25	724	.....	.....	251	118	126	90	118	118	105
26	697	.....	.....	229	157	126	96	105	126	90
27	507	.....	.....	244	149	134	64	118	113	77
28	383	.....	.....	244	167	90	69	134	90	46
29	360	.....	.....	251	185	126	105	118	77	54
30	408	.....	.....	251	157	126	90	118	85	64
31	432	.....	.....	.....	105	96	.....	118	.....	64

[a] 12-inch flashboards on from July 16 to December 31, inclusive.

COBBOSSEECONTEE RIVER AT GARDINER, ME.

Cobbosseecontee River drains a group of lakes lying from 5 to 15 miles westerly from Augusta, having areas aggregating 19 square miles, and empties into the Kennebec 6 miles below that city at Gardiner. Its total drainage area is about 240 square miles. From the ordinary surface of Lake Maranacook, one of the upper lakes, to mean tide at the mouth of the river the fall is 206 feet, and in the lower three-fourths of a mile it is said to be 136 feet. From above the uppermost of the 8 dams controlled by the Gardiner Water Power Company, which are in the latter three-fourths of a mile, the municipal water supply for Gardiner is drawn and pumped by water power. Record is kept of the water pumped and of the water that passes the dam through a waste gate. The sum of these quantities represents the yield of the drainage area at the upper dam, records of which have been kept by the Gardiner Water Power Company for a series of years, and have been furnished to the Survey by their engineer, A. H. Twombly.

The record for 1904 is presented in the accompanying table. C Sundays and legal holidays the gates are closed and no water is pe mitted to run, unless the lakes are full. This is a most remarkab example of the regularity of flow that can be obtained with prop storage.

Mean daily discharge, in second-feet, of Cobbosseecontee River at Gardiner, Me., for 19

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	De
1	200	180	160	280	2,747	280	280	265	265	265	250	
2	200	180	160	280	2,497	280	280	265	265	00	250	
3	00	180	160	00	1,859	280	30	265	265	265	250	
4	200	180	200	280	725	280	29	265	00	265	250	0
5	200	180	200	280	351	00	280	265	265	265	250	
6	200	180	00	286	283	280	280	265	265	265	00	
7	200	00	220	306	280	280	280	00	265	265	220	
8	200	160	250	286	393	280	280	265	265	265	220	
9	200	160	250	320	500	280	280	265	265	00	220	
10	00	160	280	532	956	280	00	265	265	265	220	
11	200	160	290	618	1,406	280	280	265	00	250	220	0
12	180	160	280	497	2,129	00	280	265	265	250	220	
13	180	160	186	399	1,699	280	280	265	265	250	00	
14	160	00	280	270	1,105	280	280	00	265	250	220	
15	180	160	280	276	362	280	280	265	265	250	220	
16	180	160	280	276	280	280	280	265	265	00	220	
17	00	160	280	270	537	280	00	265	265	250	220	
18	180	130	280	270	670	280	280	265	00	250	220	(
19	180	125	280	270	699	00	280	265	265	250	220	
20	180	125	00	250	699	280	280	265	265	250	00	
21	180	00	280	372	699	280	265	00	265	250	220	
22	180	120	280	462	634	280	265	265	265	250	220	
23	180	135	280	421	489	280	265	265	265	00	220	
24	00	150	280	250	415	280	00	265	265	250	00	
25	180	160	337	331	300	280	265	265	00	250	220	
26	180	160	494	331	280	00	265	265	265	250	220	
27	180	160	649	405	280	280	265	265	265	250	00	
28	180	00	564	565	280	280	265	00	265	250	220	
29	180	160	529	2,652	00	280	265	265	265	250	220	
30	180	.....	329	2,747	280	280	265	265	00	200	220	
31	00	.....	280	.....	280	.....	.....	265	.....	250	.....	

ANDROSCOGGIN RIVER DRAINAGE BASIN.

Androscoggin River is formed by the junction of Magalloway Ri and the outlet of the Umbagog-Rangeley lakes near the Maine-N Hampshire boundary line. For about 35 miles it flows southward i the State of New Hampshire, then turns abruptly to the east and fl into the State of Maine, then turns to the south and joins the Ken bec in Merrymeeting Bay. The last fall on the Androscoggin is Brunswick, Me., above which place the drainage area is 3,470 squ miles, about 80 per cent of which is in Maine. The greatest lengt the basin is 110 miles, the greatest width 70 miles, while the ri itself measures about 200 miles in length from the sources of Maga

way River to the coast. The following table gives the drainage areas of the river and of some of its chief tributaries:

Drainage areas of Androscoggin River and principal tributaries.

River.	Locality.	Drainage area.
		Square miles.
Androscoggin	Immediately below junction of Umbagog outlet and Magalloway River, at Errol dam.	1,090
Do	Berlin	1,350
Do	Gorham	1,375
Do	Shelburne	1,500
Do	Rumford Falls	2,090
Do	Dixfield	2,230
Do	Livermore Falls	2,550
Do	Lewiston Falls	2,950
Do	Brunswick	3,470
Umbagog outlet	Immediately above junction with Magalloway River.	590
Magalloway	Mouth	500
Little Androscoggin	do	380

The lower part of the basin is hilly and moderately wooded, while the upper two thirds is broken and mountainous, heavily timbered, and with a gravelly, sandy soil. Granite, gneiss, and mica-schists abound along the main course of the river, with clay slate in the upper part of the basin. The river, like others on the southern slopes of Maine, generally has a rocky bed, particularly where falls occur; has high banks, and is seldom subject to overflow, all of which are features of advantage in the development of water powers. Below Berlin the facilities for rail transportation are excellent. Tide-water navigation extends to the falls at Brunswick.

The United States Geological Survey now maintains gaging stations on this river at Shelburne, N. H., and Dixfield, Me.

In addition to these stations, data on the flow of the Androscoggin River is obtained through private parties, at the following points: Errol dam, N. H.; Gorham, N. H.; and at Rumford Falls, Me.

ANDROSCOGGIN RIVER AT ERROL DAM, NEW HAMPSHIRE.

Four large storage dams are maintained in the Umbagog-Rangeley Lake system. They are located at the outlets of Rangeley, Moosehlucmaguntic, Richardson, and Umbagog lakes. Errol dam, at the outlet of Umbagog Lake, is the lowest of the series and is below the mouth of Magalloway River. The other three dams control completely the flow from the basin above Richardson Lake, aggregating 520 square miles in area. Errol dam controls in part the run-off from a total area of 1,090 square miles, which includes the area tributary to Richardson

Lake mentioned above, but its height is not sufficient to store the tota freshet flow.

The United States Geological Survey, cooperating with Walter H. Sawyer, agent of the Union Water Power Company, Lewiston, Me., is making a series of measurements of flow through the gates at Erro dam. A continuous record of gate openings is kept and when a suf ficient number of measurements have been made to warrant the con struction of a rating curve for the gates a continuous record of flow at this point will be available. The results of these measurements are not yet ready for publication.

ANDROSCOGGIN RIVER AT GORHAM, N. H.

During the year 1903 the Berlin Mills Company constructed a tight crib dam in Androscoggin River at Gorham. From November 27, 1903, until the end of the year estimates of discharge were obtained by means of a rectangular notch constructed in the dam, and the records furnished by H. S. Ferguson, engineer for the company. (For which see Water-Supply Paper No. 97.) No records of flow are available for 1904 at this point. Drainage area here is 1,375 square miles.

ANDROSCOGGIN RIVER AT SHELBURNE, N. H.

This station was established May 30, 1903, by N. C. Grover. It is located at the steel highway bridge about one-half mile north of the railway station at Shelburne. The drainage area at this point is 1,50 square miles. A standard chain gage is attached to the guard timbe on the downstream side of the bridge; length of chain, 20.66 feet whe gage was established. This was changed to 20.72 feet on August 4 1904, owing to change in flooring of bridge and consequent position c gage. It is referred to bench marks as follows: (1) Marked point c south edge of most westerly cylindrical pier; elevation, 17.82 fee (2) Marked point on lower chord near gage; elevation, 18.77 fee (3) Highest point of bowlder near most easterly pier; elevation, 7.1 feet. All elevations refer to the datum of the gage. The initial poi for soundings is on the left bank of the river at the end of the inclin end post of the downstream truss. The channel of the river is straig for 500 feet above and 1,000 feet below the station, is about 400 fe wide at ordinary stages, and is broken by two piers. The bed of tl river is sandy and usually permanent, but in case of serious obstru tions to the channel by ice or logs, noticeable changes take place. Tl velocity is swift at high stages, but becomes low and poorly distribute with considerable obliquity, at medium and low water conditions, wh measurements are made from a boat at a point about 1,000 feet belo the bridge, where an excellent site exists for gaging. The banks c both sides are subject to overflow in extreme freshets. The gage read twice daily by James Simpson, postmaster at Shelburne.

The observations at this station during 1904 have been made und the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Androscoggin River at Shelburne, N. H., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 18	N. C. Grover	1,010	2.00	4.55	2,020
May 12	S. K. Clapp	2,420	4.08	7.65	9,880
May 25	N. C. Grover	1,600	2.61	5.59	4,170
June 15	S. K. Clapp	1,280	1.95	4.72	2,500
July 22	do	953	1.43	3.94	1,360
August 29[a]	F. E. Pressey	650	2.98	4.48	1,940
November 15[a]	do	510	2.35	4.22	1,200

[a] Made from boat.

Mean daily gage height, in feet, of Androscoggin River at Shelburne, N. H., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1					6.70	5.10	4.95	4.00	4.40	4.40	4.80	4.65
2					7.55	5.00	5.00	4.00	4.30	4.50	4.70	4.70
3	[a] 6.30			[b] 6.30	8.30	4.95	5.10	4.00	4.35	4.40	4.55	[c] 4.90
4					8.60	4.90	5.05	4.05	4.40	4.40	4.45	
5					8.55	4.90	5.10	4.10	4.40	4.40	4.40	
6			[d] 6.20		8.50	4.90	5.20	4.00	4.40	4.40	4.35	
7		[e] 6.20			8.50	4.95	5.10	4.10	4.40	4.35	4.30	
8					8.50	5.00	5.05	4.20	4.40	4.40	4.40	
9				[f] 5.25	8.55	4.95	5.00	4.10	4.30	4.40	4.30	
10	[g] 6.10			6.35	8.35	4.90	4.95	4.10	4.40	4.50	4.40	
11				6.10	8.60	4.90	4.85	4.10	4.40	4.50	4.35	6.25
12				5.35	7.75	4.80	4.85	4.10	4.45	4.50	4.30	
13			[h] 6.30	4.90	7.30	4.80	4.70	4.20	4.40	4.40	4.30	[i] 6.30
14		[j] 5.40		4.40	6.80	4.70	4.65	4.35	4.40	4.45	4.35	
15				4.50	6.75	4.60	4.35	4.40	4.40	4.50	4.35	
16				4.45	7.00	4.60	4.25	4.40	4.40	4.40	4.20	
17	[k] 6.30			4.45	7.85	4.50	4.35	4.30	4.40	4.50	4.20	
18				4.60	7.55	4.60	4.40	4.20	4.45	4.40	4.20	
19				4.70	7.60	4.60	4.15	4.15	4.50	4.40	4.20	[l] 6.40
20			[m] 6.70	4.80	7.50	4.60	4.20	4.20	4.50	4.50	4.30	
21		[n] 5.20		4.60	6.70	4.50	4.05	4.20	4.40	5.00	4.30	
22				4.60	6.25	4.60	4.00	4.15	4.45	5.00	4.20	
23				4.70	6.05	4.55	3.95	4.00	4.45	4.75	4.20	
24	[o] 6.10			5.00	5.90	4.60	4.05	4.10	4.40	4.65	4.20	
25				5.70	5.70	4.65	4.00	4.10	4.50	4.55	4.20	[p] 6.30
26				5.70	5.60	4.70	4.10	4.10	4.50	4.70	4.20	
27			[k] 8.50	5.50	5.30	4.70	4.00	4.10	4.50	5.05	4.15	
28		[e] 6.40		5.80	5.35	4.75	3.95	4.20	4.50	5.10	4.10	
29				7.05	5.20	4.80	3.95	4.30	4.45	4.95	4.20	
30				6.85	5.10	4.85	4.05	4.30	4.50	4.95	4.30	
31	[q] 6.40				5.10		4.10	4.40		4.80		

[a] Ice 1.25 feet thick.
[b] Ice 1.85 feet thick.
[c] Frozen over.
[d] Ice 2.9 feet thick.
[e] Ice 3.5 feet thick.
[f] Ice went out during night.
[g] Ice 1.9 feet thick.
[h] Ice 2.85 feet thick.
[i] Ice 2.1 feet thick.
[j] Ice 4.1 feet thick.
[k] Ice 2.5 feet thick.
[l] Ice 2.2 feet thick.
[m] Ice 2.7 feet thick.
[n] Ice 4.35 feet thick.
[o] Ice 2.75 feet thick.
[p] Gage height to top of ice=6.55; ice 2.1 feet thick.
[q] Ice 3.1 feet thick.

NOTE.—Gage heights during frozen season are to surface of water in hole cut in ice under gage.

ANDROSCOGGIN RIVER AT RUMFORD FALLS, ME.

One of the finest water powers in the Atlantic Coast drainage is at Rumford Falls. Here the Androscoggin descends 177 feet in 1 mile in several pitches over granite ledges. A comprehensive plan of development has been laid out and partly executed. It contemplates the use of power from three levels—a high-level canal, with a fall of 97 feet to the middle level, which receives also a direct and independent supply of water from the river. The water in the middle-level canal is then used and discharged after a fall of 50 feet into the low level, from which in turn there is a final drop of 30 feet to the river. Dams have been built at the entrance of the high and middle level canals. At present about 19,000-horsepower are utilized, largely in the manufacture of pulp and paper. An economical development of the entire fall of 177 feet would furnish 50,000 horsepower. This power is 85 miles by rail from Portland, and for pulp and paper manufacture has the advantage of excellent transportation facilities. Androscoggin River is used for floating down pulp wood and timber from the headwaters to the mills, and the Rumford Falls and Rangeley Lakes Railroad, extending into the forests with its extension into the Megantic region, makes available the remoter resources of spruce, poplar, and birch.

The discharge of Androscoggin River at Rumford Falls since 1892 has been computed by Charles A. Mixer, resident engineer of the Rumford Falls Power Company. These statistics are obtained by adding the actual measured quantities passing through the wheels to the computed flow over the dam, using the customary Francis weir formula with modified coefficient. They have been published from time to time by the United States Geological Survey, and a complete record up to 1902 will be found in Water-Supply Paper No. 69.

ANDROSCOGGIN RIVER NEAR DIXFIELD, ME.

This station was established August 22, 1902, by F. E. Pressey. It is located about one-half mile west of Dixfield, at the highway bridge on the road to West Peru. The measurements are made from this bridge or from a boat at low water. The initial point for soundings is at the lower end of the inclined end post of the downstream truss on the left bank of the river. The gage is of the standard chain type; the scale board is nailed to the guard timber on the lower side of the bridge; length of chain, 31.76 feet. It is referred to bench marks as follows: (1) Southeast corner of bridge seat on north abutment; elevation, 24.77 feet. (2) Copper bolt in ledge under east end of bridge; elevation, 11.53 feet. (3) Top of short post at west hanger in east span; elevation, 33.15 feet when gage was established; found to be 33.08 feet on August 3, 1904; probably due to settlement of post. All elevations refer to the datum of the gage. The channel is straight for 1,000 feet above and one-half mile below the station, and is about 600 feet wide, broken by three piers. The banks are high

ɔle to overflow. The bed of the stream is rocky in the left ınıdy in the right half. The velocity is medium at high , is poorly distributed at low water, when the current is the right half. Under such conditions measurements are the bridge for only the two left-hand portions of the chan- he remaining part is gaged by wading at a point about 250 ;ream—it being possible to do this on account of a sandy ing these two parts. The gage is read twice daily by S. F.

rvations at this station during 1904 have been made under ın of H. K. Barrows, district hydrographer.

rge measurement of Androscoggin River near Dixfield, Me., in 1904.

	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
..	H. K. Barrows.....	1,200	1.31	7.68	1,570

gage height, in feet, of Androscoggin River near Dixfield, Me., for 1904.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	.....	8.85	12.95	8.80	8.60	7.80	7.55	8.55	8.25	7.90
a 9.60	.....	b 9.40	8.65	12.45	8.75	8.85	7.85	7.45	8.45	8.10	8.00
.....	c 9.20	.....	8.70	12.30	8.70	8.95	7.75	7.50	8.20	8.00	7.70
.....	.....	.....	8.65	12.45	8.60	8.85	7.85	7.70	8.15	7.95	7.65
.....	.....	.....	8.50	12.30	8.65	8.90	7.75	7.60	8.05	8.00	7.80
.....	c 9.20	.....	8.90	12.15	8.75	8.85	7.70	7.30	7.90	7.90	8.10
d 9.60	.....	.....	9.30	11.65	8.95	8.55	7.65	7.60	7.95	7.90	8.10
.....	.....	b 9.85	9.25	11.55	8.95	8.20	7.50	7.60	8.00	8.00	8.50
.....	.....	.....	10.00	11.45	8.90	8.15	7.55	7.55	7.90	7.90	9.10
.....	.....	.....	11.20	12.25	8.80	8.10	7.65	7.45	7.90	7.95	10.00
d 9.70	c 9.10	b 10.30	12.00	12.10	8.75	8.00	7.65	7.55	8.05	7.95	.....
.....	.....	.....	10.95	11.80	8.75	8.10	7.65	7.40	8.00	8.00	.....
d 9.70	.....	.....	10.20	11.10	8.70	8.15	7.75	7.60	7.95	8.00	.....
d 9.00	.....	.....	9.55	10.65	8.70	8.05	7.80	7.70	8.00	7.95	.....
.....	c 9.10	b 10.10	9.10	10.30	8.70	7.90	7.50	8.40	7.95	7.85	e 9.40
f 9.50	.....	.....	9.05	11.00	8.60	7.95	7.75	9.15	7.95	8.05	.....
.....	.....	b 9.70	8.80	12.05	8.65	7.85	7.70	8.50	7.65	7.90	.....
.....	c 9.10	.....	8.85	11.60	8.60	7.70	7.60	8.00	8.00	7.75	.....
.....	.....	.....	9.05	11.50	8.50	7.80	7.55	7.55	7.90	7.90	.....
g 9.50	.....	.....	9.50	12.35	8.55	7.70	7.60	7.55	7.85	7.75	.....
.....	.....	.....	9.25	11.30	8.55	7.60	9.05	7.85	7.85	7.85	.....
.....	h 9.20	.....	9.20	10.45	8.55	7.55	8.50	8.20	11.05	7.95	.....
.....	.....	i 9.20	9.45	10.10	8.60	7.45	8.25	8.05	9.45	7.95	.....
e 9.40	.....	.....	9.90	9.95	8.60	7.70	8.00	7.90	8.60	8.00	j 10.00
.....	.....	.....	10.55	9.65	8.50	7.80	7.90	7.90	8.60	8.05	.....
.....	.....	k 9.60	10.85	9.50	8.60	7.95	7.80	7.90	8.65	8.00	.....
.....	i 9.40	12.25	10.70	9.40	8.55	8.20	7.70	8.25	9.00	7.90	.....
.....	.....	11.85	10.60	9.25	8.55	8.20	7.70	8.00	8.85	7.90	.....
.....	.....	10.10	12.25	9.10	8.50	8.35	7.50	7.90	8.60	7.90	.....
c 9.20	.....	9.15	13.65	8.95	8.45	8.25	7.55	8.40	8.40	7.85	.....
.....	.....	8.80	.....	8.85	.....	7.80	7.60	.....	8.10	.....	f 9.90

ɔot. *d* Ice 1.2 feet. *g* Ice 1.4 feet. *j* Ice 1.1 feet.
ɜet. *e* Ice 0.7 foot. *h* Ice 1.7 feet. *k* Channel cut through at 2 p. m.
ɜet. *f* Ice 1.3 feet. *i* Ice 1.6 feet.

PRESUMPSCOT RIVER DRAINAGE BASIN.

This is one of the most interesting as well as one of the best water-power streams of its size in the United States. It is the outlet of Sebago Lake, which lies about 17 miles northwest of Portland. The lake is fed by Crooked River, a stream heading 35 miles farther north and within 3 miles of the Androscoggin. The area of the lake is 50 square miles, the area of its drainage basin at the outlet of the lake 420 square miles, and the total drainage area of the river at its mouth 600 square miles. The northern part of the basin is mountainous and wooded, while the southern part is moderately hilly and cleared of trees. Granite, gneiss, and mica schists appear at many points, and the soil is gravelly and sandy.

According to the survey made by Joseph A. Warren, of Cumberland Mills, the fall from the crest of the stone dam at the foot of Sebago Lake to mean low tide at the foot of the lower falls is 265.16 feet in a distance of 21.65 miles, or an average of 12.25 feet per mile. In the lower two-thirds of this distance, or from Gambo Falls to tide water, nearly one-half of the whole fall, or 132 feet, has been developed, and an aggregate probably exceeding 6,000 net horsepower is in use. The remainder of the fall, however, between Gambo Falls and Sebago Lake, amounting to 133 feet, is either unimproved or but slightly utilized. At Great Falls, in this stretch, there is a descent of 22 feet, which has been used in the past but is now idle. It is proposed, however, to employ the power in the generation of electricity for delivery in Portland.

The tributaries of Presumpscot River are not of much importance, but some of them are outlets of ponds and have considerable fall, thus affording constant though small power. Crooked River, the chief feeder of Sebago Lake, has a number of falls, some of which are utilized.

The chief interest attaching to the river is its regularity of flow, which is due to dams at the outlet of the lake. Nowhere in the United States is there a better example of the success of storage of water and regulation of the flow of a stream than on the Presumpscot.

PRESUMPSCOT RIVER AT OUTLET OF SEBAGO LAKE, MAINE.

Since January, 1887, the flow from Sebago Lake has been regularly recorded, the quantity being deduced from the openings in the gates at the dam, the discharging capacity of which under different conditions of head has been determined and tabulated by Hiram F. Mills, of Lowell. Since January, 1872, a continuous record of the level of the lake surface has been kept. An unusually complete and valuable series of data has thus been obtained, which has been furnished to the United States Geological Survey by S. D. Warren & Co. The lake fills rap-

ıfter March 1, attaining its maximum height between April 15 June 1, and then gradually subsides as water is withdrawn for purposes, until a minimum stage is reached, sometimes in the nn, but usually in the winter. The records of the daily discharge e river at the outlet of the lake, published in Water-Supply r No. 69, show the remarkable uniformity of flow, which, as ly stated, is due largely to artificial regulation. On Sundays the are closed, so that only the waste is allowed to reach the river.

laily discharge, in second-feet, of Presumpscot River at outlet of Sebago Lake, Maine, for 1904.

ıy.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	678	500	370	589	333	712	724	640	757	642	688	660
.....	678	500	450	604	633	786	719	627	745	333	694	647
.....	617	500	440	300	627	728	333	627	734	705	694	642
.....	617	500	430	552	644	687	367	618	333	681	687	358
.....	617	500	437	601	648	333	687	630	767	673	698	625
.....	617	500	417	581	627	701	675	753	747	676	500	655
.....	617	450	437	571	709	720	675	333	722	653	761	635
.....	617	450	435	596	333	728	680	633	725	647	687	665
.....	617	450	422	587	673	727	658	642	795	333	687	552
.....	583	450	452	300	720	718	333	629	570	668	670	648
.....	583	450	468	524	730	731	628	617	333	682	682	360
.....	583	450	447	581	722	333	674	609	787	685	687	603
.....	583	450	250	595	734	713	702	601	745	668	705	602
.....	583	417	472	560	599	739	700	333	645	670	667	593
.....	583	417	522	622	333	742	701	598	632	683	765	583
.....	583	417	566	669	769	743	659	578	653	333	702	582
.....	533	417	563	300	720	743	333	641	648	708	700	567
.....	533	417	531	601	695	706	678	640	333	663	688	322
.....	533	417	537	658	694	333	641	635	718	670	690	567
.....	533	333	250	501	684	753	645	639	632	673	358	570
.....	533	250	524	663	688	693	614	333	615	622	655	570
.....	533	325	594	648	333	718	604	615	656	653	673	537
.....	533	375	623	650	675	694	526	635	658	333	675	540
.....	500	393	569	333	682	673	333	650	688	698	677	533
.....	500	427	437	680	680	696	658	792	333	665	697	475
.....	500	417	504	664	702	333	696	763	770	679	603	470
.....	500	377	300	681	703	655	690	600	683	668	358	495
.....	500	417	443	662	789	694	648	333	660	668	718	537
.....	500	388	493	631	0	657	619	655	649	635	658	443
.....	500	.....	562	583	79	661	608	805	663	333	655	500
.....	.....	.....	581	.....	586	.....	333	780	.....	677	.....	502

SACO RIVER DRAINAGE BASIN.

s river receives its headwaters from the valleys and slopes of /hite Mountains at elevations of 4,000 to 5,000 feet. It drains ea of 1,720 square miles, of which 900 square miles lie in New pshire and the remainder in Maine. The slopes at the head- s are very steep, with no lake storage. In the lower river are good water powers, part of which are in use. The upper por-

tions of the basin are generally in forest, but much of the large gro has been cut, and over large areas the evergreen trees have b entirely removed. In the lower basin are many farms and villa The underlying rock is generally granite, appearing at the surfac many mountain summits.

SACO RIVER NEAR CENTER CONWAY, N. H.

This station was established August 26, 1903, by N. C. Grover. is located at the wooden highway bridge between Center Conway Redstone, about 2 miles from each place. The drainage basin at point has an area of 385 square miles. A standard chain gag attached to the floor of the bridge; length of chain, 30.44 feet. referred to bench marks as follows: (1) Marked point on lower ch of bridge near gage; elevation, 27.72 feet. (2) South end of to west abutment; elevation, 25.14 feet. The channel is straight 2,000 feet above and 300 feet below the station, and is about 200 wide at ordinary stages, broken by one pier. The banks are high are not liable to overflow, except in very extreme freshets. The is of sand and gravel and is permanent. At low water the obser mean velocity is small, being 1.18 feet per second at gage height Low-water measurements are usually made by wading about 400 above the bridge, where a mean velocity of 1.22 feet per second observed at gage height 3.92. The gage is read twice daily by All P. Davidson.

The observations at this station during 1904 have been made ur the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Saco River near Center Conway, N. H., in 1903 and 19

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Disch
1903.			*Square feet.*	*Ft. per sec.*	*Feet.*	*Second*
Aug. 26	H. K. Barrows	167	429	1.18	4.31	
27[a]	do	277	294	1.30	4.13	
Sept. 19[a]	do	275	295	1.22	3.92	
1904.						
Apr. 19	N. C. Grover	227	738	2.20	5.87	
May 2	S. K. Clapp	251	1,477	3.88	9.00	
13	do	235	986	2.83	7.00	
26	N. C. Grover	224	740	2.12	5.76	
June 14	S. K. Clapp	144	417	1.17	4.11	
July 21[a]	do	230	119	1.27	3.39	
Aug. 9	do	200	141	1.31	3.45	
Oct. 11[a]	T. W. Norcross	280	320	1.14	3.88	
11[a]	do	280	321	1.14	3.92	

[a] At wading section.

daily gage height, in feet, of Saco River near Center Conway, N. H., for 1904.

.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	.....	.....	5.75	9.90	4.70	4.10	3.45	3.38	5.46	4.36	.....
.....	.....	.....	.....	5.50	9.22	4.65	4.38	3.46	3.37	4.94	4.62	.....
.....	7.10	.....	.....	5.55	8.60	4.58	4.18	3.56	3.37	4.68	4.30	.....
.....	.....	.....	.....	5.30	8.82	4.52	3.98	3.67	3.82	4.50	4.25	.....
.....	.....	.....	.....	5.28	9.02	4.52	3.84	3.60	3.76	4.26	4.14	.....
.....	.....	.....	[a] 7.50	5.75	8.48	4.68	3.78	3.54	3.54	4.19	4.15	.....
.....	6.10	.....	.....	6.18	7.72	4.72	3.74	3.52	3.45	4.26	4.15	.....
.....	.....	.....	.....	5.98	7.72	4.61	3.66	3.45	3.41	3.98	4.10	.....
.....	.....	.....	.....	7.10	7.58	4.47	3.62	3.42	3.37	3.94	4.00	.....
.....	[b] 7.00	.....	.....	9.70	8.85	4.38	3.58	3.42	3.41	3.93	3.95	.....
.....	.....	.....	.....	8.68	9.10	4.28	3.57	3.44	3.36	4.04	3.95	(c)
.....	.....	.....	.....	7.75	7.68	4.20	3.60	3.48	3.32	3.89	3.90	.....
.....	.....	.....	(c)	7.08	7.04	4.15	3.70	3.46	3.32	3.89	3.85	.....
.....	.....	[d] 6.40	.....	6.60	6.68	4.12	3.62	3.47	3.26	3.57	4.05	.....
.....	.....	.....	.....	6.20	7.10	4.07	3.58	3.44	5.34	3.86	4.05	.....
.....	.....	.....	.....	6.05	8.94	4.05	3.54	3.44	5.43	3.85	4.00	.....
.....	[e] 7.00	.....	.....	5.70	8.06	3.58	3.45	3.42	4.41	3.92	3.95	.....
.....	.....	.....	.....	5.70	7.58	3.92	3.46	3.42	4.05	3.92	3.75	[f] 4.25
.....	.....	.....	.....	5.82	9.24	3.84	3.42	3.35	3.90	3.83	(g)	.....
.....	.....	.....	(c)	6.20	9.58	3.83	3.42	3.54	3.86	3.88	(g)	.....
.....	.....	[d] 6.20	.....	5.88	7.78	3.75	3.40	6.18	3.92	8.13	4.1	.....
.....	.....	.....	.....	5.72	6.98	3.88	3.38	4.48	4.05	5.86	4.2	.....
.....	.....	.....	.....	5.94	6.16	3.95	3.38	4.04	3.68	5.86	4.1	.....
.....	[h] 7.00	.....	.....	6.35	6.28	3.83	3.40	3.62	3.76	5.25	4.1	.....
.....	.....	.....	.....	7.20	6.01	3.75	3.46	3.72	4.75	4.92	4.0	[i] 4.30
.....	.....	.....	.....	7.90	5.78	3.70	3.52	3.63	4.34	5.12	3.9	.....
.....	.....	.....	(c)	7.75	5.58	3.70	3.56	3.56	4.20	4.90	4.0	.....
.....	.....	[d] 6.70	.....	7.78	5.35	3.65	3.74	3.54	4.42	4.56	4.1	.....
.....	.....	.....	.....	10.02	5.01	3.71	3.58	3.48	4.00	4.49	(g)	.....
.....	.....	.....	.....	10.82	4.91	3.70	3.51	3.44	5.88	4.45	.....	.....
.....	[h] 6.75	.....	{[j] 7.15 6.52}	.....	4.75	.....	3.48	3.42	.....	4.46	.....	.....

e 2.50 feet.
e 1.25 feet.
e unsafe to go upon.
e 2 feet.
e 1.35 feet.

[f] Gage height to top ice=4.5 feet—ice 1.15 feet thick.
[g] Frozen over.
[h] Ice 1.50 feet.
[i] Gage height to top ice=4.3 feet—ice 1.13 feet thick.
[j] Morning and evening readings.

-Gage heights during frozen season are to surface of water in hole in ice under gage.

Rating table of Saco River near Center Conway, N. H., from August 27, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.25	117	4.2	475	5.9	1,675	8.2	4,420
3.3	133	4.3	525	6.0	1,765	8.4	4,740
3.35	149	4.4	575	6.1	1.855	8.6	5,060
3.4	166	4.5	625	6.2	1,950	8.8	5,390
3.45	183	4.6	675	6.3	2,050	9.0	5,730
3.5	200	4.7	730	6.4	2,150	9.2	6,080
3.55	217	4.8	795	6.5	2,250	9.4	6,440
3.6	235	4.9	865	6.6	2,350	9.6	6,800
3.65	253	5.0	935	6.7	2,460	9.8	7,175
3.7	271	5.1	1,005	6.8	2,570	10.0	7,555
3.75	289	5.2	1,080	6.9	2,680	10.2	7,935
3.8	307	5.3	1,160	7.0	2,790	10.4	8,315
3.85	325	5.4	1,240	7.2	3,030	10.6	8,710
3.9	343	5.5	1,320	7.4	3,280	10.8	9,110
3.95	361	5.6	1,405	7.6	3,545		
4.0	380	5.7	1,495	7.8	3,825		
4.1	425	5.8	1,585	8.0	4,120		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 3.40 feet and 9 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Saco River near Center Conway, N. H., for 1903 and 1904.

[Drainage area, 385 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
August 26–31	530	350	402	1.04	0.23
September	405	193	264	.69	.77
October	2,270	200	550	1.43	1.6[illegible]
November 1–26	465	239	339	.88	.8[illegible]
1904.					
April	9,110	1,160	2,815	7.31	8.1[illegible]
May	7,365	760	3,682	9.56	11.0[illegible]
June	742	228	451	1.17	1.3[illegible]
July	565	159	250	.65	.7[illegible]
August	1,930	149	276	.72	.83
September	1,657	120	411	1.07	1.19
October	4,345	224	754	1.96	2.26
November 1–18	685	289	424	1.10	.73

MERRIMAC RIVER DRAINAGE BASIN.

This basin, which has a total drainage area of 5,015 square miles, lies in the States of New Hampshire and Massachusetts; of this, 3,815 square miles are in the former State and 1,200 square miles in the latter. Merrimac River is formed at Franklin, N. H., by the junction of Pemigewasset and Winnepesaukee rivers. The headwaters of the Pemigewasset lie in the White Mountain region at elevations of approximately 2,000 feet; thence they flow southerly through New Hampshire with very steep slopes. On this branch of the Merrimac there is very little lake storage. Squam and New Found lakes, aggregating about 20 square miles of surface area, are the only bodies of water of any importance. Above Plymouth probably 85 per cent of the basin is in heavy forest. A very insignificant amount of water power is utilized. Winnepesaukee River has its headwaters in the eastern part of the State. A prominent characteristic of its basin is the extent of the lake surface, aggregating 100 square miles. The fall from Winnepesaukee Lake to the junction with Pemigewasset River is 225 feet in a distance of 14 miles.[a]

From Franklin Merrimac River flows southerly through the State of New Hampshire for 56 miles, receiving Contoocook River from the west and Suncook River from the east. After entering Massachusetts the river deflects to the east and flows in an easterly and northeasterly direction, a distance of 40 miles, to Newburyport, where it enters an arm of the sea. Tide flows to Lawrence.

The United States Geological Survey maintains gaging stations in this basin on Merrimac River at Franklin Junction; on Pemigewasset River at Plymouth; on Contoocook River at West Hopkinton, and on Suncook River at East Pembroke.

In addition, data of flow are furnished the Survey by private parties or corporations for Merrimac River at Garvins Falls, near Concord, N. H.; Merrimac River at Lawrence; Sudbury River at Framingham; Lake Cochituate at Cochituate, Mass., and the South Branch of Nashua River at Clinton, Mass.

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[a] Tenth Census, vol. 16, p. 50.

Drainage areas of Merrimac River and some of its principal tributaries are given in the following table:

Drainage area of Merrimac River and tributaries.

River.	Locality.	Drainage area.
		Sq. miles.
Merrimac	Mouth	5,015
Do	Lawrence dam	4,664
Do	Lowell dam	4,127
Do	Garvins Falls	2,340
Do	Franklin Junction	1,460
Pemigewasset	Plymouth	615
Do	Junction with Winnepesaukee	1,085
Winnepesaukee	Junction with Pemigewasset	435
Contoocook	West Hopkinton	410
Do	Mouth	750
Suncook	East Pembroke	250
Do	Mouth	270

MERRIMAC RIVER AT FRANKLIN JUNCTION, N. H.

This station was established July 8, 1903, by H. K. Barrows. It is located at the wooden railway bridge near Franklin Junction, about a mile below the union of Pemigewasset and Winnepesaukee rivers. The drainage area at this point is 1,460 square miles. A standard chain gage is fastened to the guard timber of the bridge; length of chain, 47.08 feet. It is referenced by bench marks as follows: (1) Marked point on lower chord near gage; elevation, 46.54 feet. (2) Top of north rail at west portal of bridge; elevation, 47.08 feet. (3) Spike in telegraph pole nearest west end of bridge; elevation, 46.38 feet. (4) Top of northwest nut on guard timber; elevation, 47.28 feet. All elevations refer to the datum of the gage. The initial point for soundings is at the top of the face of the right abutment at the upstream side of the bridge. The channel is straight above and below the bridge and is about 200 feet wide at ordinary stages, broken by one pier. The banks are high and rocky and not subject to overflow. The bed is rocky and permanent. The current is swift, having an observed mean velocity of 1.53 feet per second at a gage height of 4.20, the lowest measurement made. The gage is read twice daily by F. R. Roers.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Merrimac River at Franklin Junction, N. H., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 13	H. K. Barrows	805	1.84	4.46	1,480
July 14	do	768	1.85	4.42	1,420
July 31	do	840	1.93	4.66	1,620
September 5	do	840	2.00	4.67	1,680
September 9	do	745	1.53	4.20	1,140
October 8	N. C. Grover	724	1.48	4.17	1,070
1904.					
April 6	N. C. Grover	1,250	4.31	6.83	5,400
April 21	S. K. Clapp	1,260	3.96	6.46	4,990
May 4	do	1,830	5.46	8.92	9,990
May 24	N. C. Grover	1,285	4.15	6.88	5,330
June 8	S. K. Clapp	1,020	3.10	5.47	3,170
July 7	do	812	2.09	4.51	1,700
September 23	T. W. Norcross	790	2.03	4.66	1,600
November 8	do	855	1.79	4.50	1,530

Mean daily gage height, in feet, of Merrimac River at Franklin Junction, N. H., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.70	.....	.....	7.75	12.90	5.30	4.50	4.40	4.10	7.00	4.85	4.00
2	4.80	.....	.....	7.15	10.10	5.20	4.90	4.40	4.20	5.70	4.80	4.00
3	4.70	.....	.....	6.10	8.90	5.20	4.55	4.40	4.10	5.60	4.70	3.90
4	(a)	.....	.....	6.30	8.80	5.20	4.50	4.35	3.90	5.45	4.70	3.60
5	.....	.....	.....	6.15	8.60	4.80	4.50	4.40	4.20	5.30	4.60	3.90
6	.....	.....	.....	6.90	8.45	5.35	4.40	4.50	4.30	5.10	4.30	4.00
7	.....	.....	.....	7.90	7.45	5.50	4.40	3.95	4.25	4.90	4.40	4.10
8	.....	.....	.....	7.90	6.70	5.45	4.40	4.50	4.20	4.70	4.45	4.20
9	.....	.....	.....	9.40	7.05	5.40	4.40	4.30	4.20	4.10	4.40	4.10
10	.....	.....	.....	11.50	7.00	5.20	3.90	4.30	4.15	4.60	4.40	4.10
11	.....	.....	.....	10.65	7.00	5.05	4.25	4.35	4.10	4.80	4.30	4.45
12	.....	.....	.....	8.35	6.90	4.90	4.30	4.40	4.10	4.70	4.30	4.80
13	.....	.....	.....	7.90	6.70	5.10	4.20	4.50	4.20	4.80	4.30	4.50
14	.....	.....	.....	7.10	6.70	4.80	4.25	3.90	4.20	4.80	4.30	4.30
15	.....	.....	5.50	6.55	6.60	4.60	4.30	4.10	5.00	4.75	4.40	4.40
16	.....	.....	5.50	6.30	7.90	4.60	4.20	4.15	7.05	4.20	4.40	4.40
17	.....	.....	5.10	6.30	11.40	4.60	3.70	4.10	5.55	4.40	4.40	4.40
18	.....	.....	5.10	6.10	10.40	4.50	4.10	4.10	4.55	4.50	4.30	(a)
19	.....	.....	4.70	6.15	7.90	4.35	4.15	4.05	4.60	4.60	4.20	.....
20	.....	.....	4.15	6.20	12.50	4.30	4.10	4.25	4.60	4.60	4.05	.....
21	.....	.....	4.50	6.30	9.80	4.25	4.20	7.60	4.70	4.70	4.20	.....
22	.....	.....	4.45	6.40	7.20	4.30	4.20	5.90	4.90	7.85	4.40	.....
23	.....	.....	4.70	6.55	7.30	4.30	4.10	5.65	4.75	.....	4.35	.....
24	.....	.....	5.80	6.70	6.85	4.35	3.75	5.70	4.50	.....	4.30	.....
25	.....	.....	6.30	7.65	6.20	4.20	3.95	5.10	3.95	.....	4.30	.....
26	.....	.....	7.10	8.70	6.30	4.15	4.10	4.40	5.80	.....	4.30	.....
27	.....	.....	8.10	8.55	6.25	4.10	4.20	4.40	5.45	.....	3.60	.....
28	.....	.....	9.10	10.10	5.90	4.10	4.40	3.75	5.20	.....	4.00	.....
29	.....	.....	7.80	12.30	5.30	4.20	4.45	4.05	5.20	.....	3.95	.....
30	.....	.....	7.70	13.45	5.50	4.30	4.30	4.15	7.70	.....	3.90	.....
31	.....	.....	7.70	.....	5.50	.....	3.75	4.10	.....	.....	.....	.....

a River frozen from January 4 to March 15 and from December 18 to 31.

Rating table for Merrimac River at Franklin Junction, N. H., from July 8, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.6	460	4.9	2,065	6.2	4,310	8.6	9,265
3.7	570	5.0	2,220	6.3	4,500	8.8	9,715
3.8	680	5.1	2,380	6.4	4,690	9.0	10,170
3.9	795	5.2	2,540	6.6	5,070	9.5	11,320
4.0	910	5.3	2,705	6.8	5,460	10.0	12,470
4.1	1,030	5.4	2,875	7.0	5,850	10.5	13,670
4.2	1,150	5.5	3,045	7.2	6,250	11.0	14,870
4.3	1,270	5.6	3,220	7.4	6,660	11.5	16,080
4.4	1,395	5.7	3,395	7.6	7,075	12.0	17,330
4.5	1,520	5.8	3,575	7.8	7,500	12.5	18,580
4.6	1,645	5.9	3,755	8.0	7,930		
4.7	1,775	6.0	3,940	8.2	8,370		
4.8	1,915	6.1	4,125	8.4	8,815		

The above table is applicable only for open-channel conditions. It is based upon 14 discharge measurements made during 1903 and 1904. It is well defined between gage heights 4.15 feet and 8.90 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Merrimac River at Franklin Junction, N. H., for 1903 and 1904.

[Drainage area, 1,460 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
July 9–31	3,431	703	1,676	1.15	0.894
August	2,909	795	1,475	1.01	1.16
September	1,482	350	1,007	.690	.770
October	2,380	150	1,345	.921	1.06
November	1,710	680	1,155	.791	.882
December	4,348	680	1,412	.967	1.11
1904.					
March 15–31	10,400	1,090	4,307	2.95	1.86
April	20,950	4,125	7,825	5.36	5.98
May	19,580	2,705	7,754	5.31	6.12
June	3,045	1,030	1,866	1.28	1.43
July	2,065	570	1,203	.824	.950
August	7,075	625	1,650	1.13	1.30
September	7,285	795	1,951	1.34	1.50
October 1–22	7,608	1,030	2,415	1.65	1.35
November	1,990	460	1,312	.899	1.00
December 1–17	1,915	460	1,139	.780	.493

MERRIMAC RIVER AT GARVINS FALLS, NEW HAMPSHIRE.

. new stone masonry dam was completed at Garvins Falls, on Mer-ac River, during the spring of 1904. The drainage area at this nt is about 2,340 square miles. This dam was built by the Man-ster Traction, Light and Power Company. It has a total length about 550 feet, and is somewhat similar in section to the dam at lyoke, Mass. Very careful records of the pond and tailrace els, wheel openings, etc., are kept here, and will be furnished to United States Geological Survey. The average head on wheels is ut 29 feet.

During 1904 a number of current-meter measurements have been le by the United States Geological Survey for the purpose of rat-the turbines and to assist in computing flow over the dam. The lication of estimates of flow at this point is withheld awaiting firmation of data.

MERRIMAC RIVER AT LAWRENCE, MASS.

Records of flow of this river at Lawrence have been kept for more n fifty years, but have never been published in full. Figures for monthly maximum and minimum discharges from 1890 to 1897 e published in the Nineteenth Annual Report, Part IV; the daily charge for 1897, 1898, and 1899 in Water-Supply Paper No. 35; daily discharge for 1900 in Water-Supply Paper No. 47; the daily charge for 1901 and 1902 in Water-Supply Paper No. 82; for 1903 Water-Supply Paper No. 97. These figures are furnished by R. A. le, principal assistant engineer of the Essex Water Power Company. For a portion of the year water from the Sudbury and Nashua River inage basins is wasted into the Merrimac, and therefore the drain-area is a somewhat variable quantity. During the dry months a y small amount is received. The following tables give the flow of Merrimac at Lawrence, also the quantity wasted from the Sudbury Nashua River drainage basins that reaches the Merrimac. The er table is based on data furnished by the Metropolitan Water and verage Board of Boston. The drainage areas are as follows:

Drainage areas in Merrimac River basin.

	Sq. miles.
Total of Merrimac River drainage basin above Lawrence	4,664
Nashua River drainage basin above gaging station	119
Sudbury River drainage basin, Framingham, Dam No. 1	75
Cochituate River drainage basin	19
Total of Nashua, Sudbury, and Cochituate River drainage basins	213
Net drainage basin of Merrimac River, excluding Nashua, Sudbury, and Cochituate River basins	4,451

The quantity as measured at Lawrence includes the water from Sud-y, Nashua, and Cochituate rivers, and in getting the absolute yield

of the river this should be considered in reference to the drain areas, either by deducting it from the Merrimac flow and using net area of the Merrimac and the net flow of the Merrimac, or getting the total yield of both the Sudbury and Nashua rivers w the Merrimac and using the total area.

Flow of Merrimac River at Lawrence, Mass., for 1904.

[Cubic feet per second for twenty-four hours.]

Day.	Quantity of water passing—					
	January.	February.	March.	April.	May.	Jun
1	2,825	4,039	4,034	17,994	46,336	6
2	2,265	3,115	3,828	21,175	38,498	5
3	1,901	3,041	3,949	23,976	29,795	6
4	4,265	2,854	4,274	22,677	22,895	5
5	2,796	2,812	3,667	19,056	20,321	5
6	2,753	2,109	4,373	17,218	18,408	6
7	2,644	1,242	6,085	17,726	16,477	6
8	2,724	3,801	6,730	19,432	13,731	8
9	1,904	3,152	10,627	20,738	13,193	8
10	1,298	2,896	13,740	28,174	13,244	7
11	3,852	2,869	14,711	36,984	14,560	6
12	2,901	2,813	13,406	33,942	17,567	5
13	2,878	1,852	11,664	27,748	17,469	5
14	2,798	1,017	10,881	22,937	13,795	5
15	3,059	3,728	9,728	19,028	11,340	4
16	2,095	2,965	8,831	16,369	11,657	4
17	1,613	2,873	7,883	14,613	15,507	3
18	3,936	2,660	7,353	14,544	19,890	3
19	3,042	2,737	6,668	14,624	16,912	3
20	2,769	1,909	6,817	15,183	21,331	4
21	2,920	899	8,714	14,449	27,354	3
22	2,820	3,679	9,198	14,355	22,002	2
23	1,753	3,364	9,500	13,300	17,542	2
24	1,062	3,394	11,360	12,254	14,211	2
25	3,621	3,592	14,370	12,684	11,326	1
26	2,869	4,129	23,479	13,620	10,999	1
27	2,832	3,392	35,149	15,139	10,508	4
28	2,875	3,397	36,205	20,584	9,431	3
29	2,914	5,043	31,579	35,300	8,496	3
30	2,241	.....	23,660	45,300	7,704	3
31	1,681	.....	19,408	.....	7,721	.....
Total	81,906	85,373	381,871	621,123	540,220	140
Average	2,642	2,944	12,318	20,704	17,426	4

*Flow of Merrimac River at Lawrence, Mass., for 190*4—Continued.

ay.	Quantity of water passing—					
	July.	August.	September.	October.	November.	December.
.....	3,236	3,230	2,271	4,759	3,084	2,606
.....	3,516	2,681	2,254	5,205	3,086	2,500
.....	5,193	2,321	1,643	5,457	3,063	1,659
.....	4,586	2,651	393	4,359	3,181	390
.....	5,174	2,647	409	3,977	2,112	2,640
.....	4,575	1,799	3,378	3,623	1,656	2,434
.....	3,795	327	2,844	3,213	3,813	2,469
.....	3,340	3,163	2,370	2,128	3,006	2,498
.....	2,496	2,850	2,301	1,377	2,795	2,031
.....	2,302	2,620	1,546	3,923	2,567	1,392
.....	4,225	2,382	358	3,131	2,667	289
.....	2,881	2,529	2,303	2,973	1,702	2,255
.....	2,783	1,578	2,275	2,798	431	2,028
.....	2,716	288	2,295	3,067	3,656	2,018
.....	2,713	3,065	2,586	2,124	3,293	2,033
.....	1,667	2,850	3,396	1,946	3,107	1,977
.....	928	2,445	7,983	4,023	3,070	1,153
.....	3,758	2,549	5,595	3,031	2,858	177
.....	2,714	2,495	5,526	2,925	2,131	1,775
.....	2,662	1,550	4,423	2,780	1,049	1,886
.....	2,638	393	3,397	2,933	3,629	1,978
.....	2,403	5,267	3,156	2,076	3,094	1,962
.....	1,384	5,819	3,121	6,130	3,055	1,861
.....	367	4,494	2,003	6,808	1,096	1,164
.....	2,601	3,468	1,601	5,330	4,010	154
.....	2,680	3,489	3,942	4,607	2,632	302
.....	2,397	1,927	3,142	4,002	1,649	2,462
.....	2,485	767	3,887	3,894	3,697	2,705
.....	2,579	3,487	3,504	3,075	3,173	3,017
.....	1,661	2,402	3,486	2,674	2,540	3,022
.....	260	2,298	.....	4,364	.....	1,541
otal	86,715	79,831	87,388	112,712	80,902	56,378
.....	2,797	2,575	2,913	3,636	2,697	1,819

Average weekly flow of Merrimac River at Lawrence, Mass., for 1904.

Week ending Sunday—	Merrimac River at Lawrence (total drainage area = 4,664 square miles).	Wasting into Merrimac from—				Net yield of Merrimac River from 4, square miles.	
		Nashua River at Clinton (drainage area = 118 square miles).	Sudbury River at Dam 1 (drainage area = 75 square miles).	Lake Cochituate, Bonnister Brook (drainage area = 19 square miles).	Total waste of those watersheds (total drainage area = 212 square miles).	Cubic feet per secon	
	Cubic feet per second for seven days.					Seven days.	Persq mil
December 25	1,540	3	2	0	5	1,535	0.
December 18	1,663	3	2	0	5	1,658	.
September 11	1,887	3	2	0	5	1,882	.
January 1, 1905	1,929	3	2	0	5	1,924	.
December 11	1,965	3	2	0	5	1,960	.
July 31	2,095	3	11	0	14	2,081	
September 4	2,107	3	12	0	15	2,092	
August 21	2,192	3	20	0	23	2,169	
August 14	2,201	3	16	0	19	2,182	
August 7	2,237	4	14	0	18	2,219	
July 24	2,275	3	12	0	15	2,260	
December 4	2,366	4	2	0	6	2,360	
November 13	2,426	4	3	0	7	2,419	
February 21	2,539	4	62	0	66	2,473	
July 17	2,559	3	14	0	17	2,542	
January 24	2,615	3	39	0	42	2,573	
January 10	2,626	4	25	0	29	2,597	
February 14	2,629	4	54	0	58	2,571	
January 31	2,719	4	53	0	57	2,662	
November 20	2,738	4	3	0	7	2,731	
November 27	2,738	3	2	0	5	2,733	
January 17	2,742	4	34	0	38	2,704	
February 7	2,745	3	51	0	54	2,691	
October 16	2,852	4	2	0	6	2,846	
June 26	2,897	8	18	4	30	2,867	
November 6	2,935	4	7	0	11	2,924	
September 25	3,318	3	2	0	5	3,313	
October 23	3,414	4	2	0	6	3,408	
October 9	3,448	3	2	0	5	3,443	
February 28	3,564	4	117	0	121	3,443	
July 3	3,589	6	22	0	28	3,561	
August 28	3,604	3	32	0	35	3,569	
July 10	3,753	3	22	0	25	3,728	
September 18	3,776	4	2	0	6	3,770	
October 2	3,989	3	2	0	5	3,984	
March 6	4,167	4	112	0	116	4,051	
June 19	4,172	11	29	2	42	4,130	
October 30	4,341	3	2	0	5	4,336	
June 5	6,308	5	64	12	81	6,227	1

Average weekly flow of Merrimac River at Lawrence, Mass., for 1904—Continued.

Week ending Sunday—	Merrimac River at Lawrence (total drainage area = 4,664 square miles).	Wasting into Merrimac from— Nashua River at Clinton (drainage area = 118 square miles).	Sudbury River at Dam 1 (drainage area = 75 square miles).	Lake Cochituate, Bonnister Brook (drainage area = 19 square miles).	Total waste of those watersheds (total drainage area = 212 square miles).	Net yield of Merrimac River from 4,452 square miles. Cubic feet per second. Seven days.	Per square mile.
	Cubic feet per second for seven days.						
1904.							
June 12	6,945	99	77	15	191	6,754	1.517
March 20	8,309	7	151	0	158	8,151	1.831
March 13	10,995	8	303	0	311	10,684	2.400
May 29	11,788	23	39	14	76	11,712	2.631
April 24	14,101	38	142	19	199	13,902	3.123
May 15	14,453	171	222	45	438	14,015	3.148
March 27	15,967	8	248	0	256	15,711	3.529
May 22	19,236	113	123	32	268	18,968	4.261
April 10	20,717	179	323	100	602	20,115	4.519
May 8	22,875	115	285	17	417	22,458	5.044
April 17	24,517	397	236	112	745	23,772	5.340
April 3	24,857	12	195	33	240	24,617	5.530
May 1	26,995	813	617	76	1,506	25,489	5.725
Total, 52 weeks	335,415	2,133	3,835	481	6,449	328,966	73.892
Weekly average	6,450	41	74	9	124	6,326	1.421

PEMIGEWASSET RIVER AT PLYMOUTH, N. H.

This station was established September 5, 1903, by N. C. Grover. It is located at the wooden highway bridge, below the mouth of Bakers River, in the town of Plymouth. The drainage area at this point is about 615 square miles. The headwaters of the river lie in the mountainous country to the west of Mount Washington, at elevations of more than 2,000 feet. At North Woodstock Pemigewasset River is formed by the junction of East Branch, Middle Branch, and Moosilauke Brook, at an elevation of about 700 feet. Thence the waters flow south, receiving Mad River from the east and Bakers River from the west, until at Plymouth, about 20 miles below North Woodstock, the elevation is between 400 and 500 feet. The underlying rock in this basin is usually granite, exposed in the mountain summits. The basin contains some of the best spruce standing in New England. Large areas in the basin of East Branch are still in virgin forest; other areas have been practically stripped, especially on Hancock Brook, a tributary of East Branch, and in the basin of Middle Branch.

The height of water at Plymouth has been recorded daily since January 1, 1886, during which time extensive deforestation in the basin

above has taken place. This record of gage height has been kindly given to the United States Geological Survey by Locks and Canals Company, of Lowell, Mass. From these the daily discharge of the river since that date has been estimated from measurements of flow at the station during 1903 and 1904.

A standard chain gage is attached to the guard rail of the sidewalk of the bridge on the upstream side; length of chain, 34.69 feet. It is referred to bench marks as follows: (1) Marked point on rail of bridge near gage; elevation, 34.00 feet. (2) North corner of intermediate cast-iron gage set by Locks and Canals Company, of Lowell, Mass.; elevation, 13.27 feet. (3) North corner of lowest cast-iron gage set by same company; elevation, 7.11 feet. All elevations refer to the datum of the gage. The initial point for soundings is at the top of the face of the right abutment on the upstream side. The channel is straight for 1,000 feet above and below the bridge, and is about 180 feet wide at ordinary stages, broken by one pier. The banks are high and rocky. The bed is permanent; rocky in the right half and gravelly in the left. The velocity is rapid in the right and sluggish in the left half. At low water the measurements of flow through the left channel are made by wading. The lowest observed mean velocity is one foot per second. The gage is read twice daily by Frank Morton.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Pemigewasset River at Plymouth, N. H., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per. sec.*	*Feet.*	*Second-feet.*
September 5	N. C. Grover	250	1.08	1.85	270
September 22	H. K. Barrows	238	1.00	1.74	238
October 9	N. C. Grover	243	1.17	1.98	285
1904.					
April 14	N. C. Grover	931	2.88	4.75	2,680
April 14	do	920	2.80	4.70	2,580
April 20	S. K. Clapp	836	2.70	4.34	2,257
April 30	do	2,043	5.65	10.36	12,800
May 21	do	1,360	4.17	6.75	5,675
May 25	N. C. Grover	782	2.55	4.06	2,000
June 9	do	559	1.86	3.02	1,042
July 5	S. K. Clapp	288	1.45	2.12	419
July 26	do	197	.91	1.55	179
August 5	do	278	1.61	2.11	448
August 23	H. K. Barrows	630	2.03	3.15	1,280
September 23	S. K. Clapp	350	1.84	2.47	642
October 14	T. W. Norcross	399	1.81	2.65	722
November 22	[illegible]	356	1.73	2.54	616

Mean daily gage height, in feet, of Pemigewasset River at Plymouth, N. H., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.20	[a] 3.90	.....	.....	8.85	2.85	2.05	1.78	1.82	5.55	2.82	2.20
2	5.15	.....	.....	6.70	7.85	2.80	3.00	1.88	1.90	4.55	2.72	2.20
3	.....	.....	.....	.....	6.88	2.62	3.00	1.98	1.72	3.90	2.70	2.20
4	[b] 4.75	.....	[c] 4.65	.....	7.12	2.48	2.55	2.48	2.20	3.50	2.62	1.75
5	.....	[a] 3.65	.....	[d] 6.12	7.30	2.40	2.10	1.98	2.35	3.20	2.55	2.20
6	.....	.....	.....	3.42	6.75	2.72	2.06	1.98	1.90	3.05	2.50	1.90
7	.....	.....	[e] 4.60	5.80	5.80	2.98	2.01	1.80	1.90	2.90	2.50	2.00
8	[f] 3.90	[a] 4.25	.....	5.50	6.00	3.20	1.85	1.82	1.88	2.88	2.40	2.00
9	.....	.....	[e] 8.60	7.20	5.68	3.15	1.88	1.72	1.80	2.70	2.35	1.95
10	.....	.....	.....	9.40	6.45	2.78	1.80	1.70	1.80	2.75	2.20	2.05
11	[g] 4.20	.....	.....	7.88	8.25	2.55	1.78	1.70	1.45	2.82	2.15	1.95
12	.....	[c] 3.30	[i] 6.70	6.45	6.45	2.35	1.72	2.10	1.80	2.95	2.20	2.00
13	.....	.....	.....	5.55	5.28	2.32	1.82	2.05	1.62	2.82	2.10	1.80
14	.....	.....	[i] 6.65	4.78	4.82	2.25	1.92	1.85	1.62	2.88	2.40	2.00
15	[j] 4.40	[c] 4.10	.....	4.48	4.70	2.15	1.82	1.80	4.65	2.72	2.10	1.90
16	.....	.....	.....	4.18	8.02	2.00	1.72	2.00	4.82	2.60	2.20	1.90
17	.....	.....	.....	3.95	9.90	1.88	1.70	1.98	3.40	2.50	2.00	2.00
18	[j] 4.30	.....	.....	3.80	6.28	1.95	1.62	1.92	2.95	2.35	2.15	1.90
19	.....	[c] 4.15	[k] 4.30	4.05	6.82	1.90	1.68	1.90	2.60	2.50	2.15	2.10
20	.....	.....	.....	4.28	9.50	1.90	1.60	2.30	2.50	2.35	2.20	2.05
21	.....	.....	.....	3.92	6.62	1.95	1.62	6.62	2.80	3.20	2.35	2.05
22	[j] 4.10	[e] 4.20	[h] 5.10	3.92	5.40	2.00	1.58	3.80	2.85	7.88	2.60	1.90
23	.....	.....	.....	4.32	4.75	2.12	1.52	3.22	2.48	5.60	2.40	1.90
24	.....	.....	.....	5.25	4.35	2.00	1.45	2.85	2.40	3.88	2.20	2.05
25	[j] 4.20	.....	.....	6.70	3.98	1.98	1.58	2.50	5.30	3.42	2.20	2.20
26	.....	.....	8.30	7.52	3.80	1.95	1.58	2.32	3.75	3.35	2.30	2.10
27	.....	[e] 4.50	12.45	7.28	3.48	1.90	1.98	2.20	3.72	4.28	2.45	2.15
28	.....	.....	.....	7.82	3.42	1.88	2.50	2.00	3.20	3.62	2.45	2.30
29	[j] 4.30	[c] 4.55	10.00	8.88	3.30	1.92	2.05	1.90	3.00	3.25	2.40	2.30
30	.....	.....	.....	9.68	3.08	1.98	2.32	1.85	7.22	3.15	2.30	2.30
31	.....	.....	8.40	.....	2.95	.....	1.85	1.85	.....	2.98	.....	2.25

[a] Ice 1.65 feet.
[b] Ice 1.4 feet.
[c] Ice 1.7 feet.
[d] Ice went out.
[e] Ice 1.8 feet.
[f] Ice 1.5 feet.
[g] Ice 1.55 feet.
[h] Ice 2.2 feet.
[i] Ice 2.8 feet.
[j] Ice 1.6 feet.
[k] Ice 2.3 feet.

NOTE.—Gage heights during frozen season are to surface of water in hole cut in ice under gage.

Rating table for Pemigewasset River at Plymouth, N. H., from September 5, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.25	117	2.7	780	4.9	2,860	8.2	8,370
1.3	124	2.8	860	5.0	2,980	8.4	8,770
1.35	132	2.9	940	5.1	3,100	8.6	9,170
1.4	140	3.0	1,020	5.2	3,220	8.8	9,570
1.45	149	3.1	1,110	5.3	3,350	9.0	9,970
1.5	160	3.2	1,200	5.4	3,480	9.2	10,370
1.55	172	3.3	1,290	5.5	3,620	9.4	10,790
1.6	185	3.4	1,380	5.6	3,770	9.6	11,210
1.65	200	3.5	1,470	5.7	3,920	9.8	11,630
1.7	215	3.6	1,560	5.8	4,080	10.0	12,050
1.75	232	3.7	1,650	5.9	4,240	10.5	13,100
1.8	250	3.8	1,740	6.0	4,400	11.0	14,150
1.85	270	3.9	1,830	6.2	4,720	11.5	15,200
1.9	290	4.0	1,920	6.4	5,060	12.0	16,250
1.95	315	4.1	2,020	6.6	5,400	12.5	17,300
2.0	340	4.2	2,120	6.8	5,750	13.0	18,350
2.1	395	4.3	2,220	7.0	6,110	14.0	20,450
2.2	455	4.4	2,320	7.2	6,470	15.0	22,550
2.3	515	4.5	2,420	7.4	6,830	16.0	24,650
2.4	575	4.6	2,530	7.6	7,210	17.0	26,750
2.5	640	4.7	2,640	7.8	7,590	18.0	28,850
2.6	710	4.8	2,750	8.0	7,970		

NOTE.—This table has been applied back to January 1, 1886, as no discharge measurements were made previous to 1903.

The above table is applicable only for open-channel conditions. It is based upon 15 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.6 and 6.7 feet. Above 6.7 feet the curve depends on one measurement at 10.3 feet. The table has been extended beyond these limits. Above gage height 9.2 feet the rating curve is a tangent, the difference being 210 per tenth.

monthly discharge of Pemigewasset River at Plymouth, N. H., 1886–1904.

[Drainage area, 615 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1886.					
.....	13,310	2,805	7,247	11.78	6.57
.....	4,975	1,182	2,334	3.80	4.38
.....	2,350	593	1,085	1.76	1.96
.....	1,713	395	551	.896	1.04
.....	1,407	305	475	.772	.890
.....	2,896	185	540	.878	.980
.....	2,070	350	653	1.06	1.22
-15	3,770	964	1,828	2.97	1.66
1887.					
.....	15,720	2,717	7,295	11.86	6.62
.....	16,460	2,190	6,871	11.17	12.88
.....	20,450	766	3,006	4.89	5.46
.....	8,970	766	2,002	3.26	3.76
.....	2,020	593	1,040	1.69	1.95
.....	900	350	565	.919	1.03
.....	1,263	350	473	.769	.887
-15	497	350	413	.672	.372
1888.					
.....	22,760	1,858	5,309	8.64	4.82
.....	20,140	3,415	8,756	14.24	16.42
.....	5,400	350	1,867	3.04	3.39
.....	1,632	350	697	1.13	1.30
.....	2,020	305	684	1.11	1.28
.....	7,685	350	1,816	2.95	3.29
.....	6,290	1,335	2,729	4.44	5.12
-15	7,020	1,857	3,066	4.99	2.78
1889.					
.....	8,870	2,350	5,315	8.64	4.82
.....	7,400	964	2,092	3.40	3.92
.....	11,210	654	2,183	3.55	3.96
.....	7,495	545	1,700	2.76	3.18
.....	7,875	350	1,362	2.21	2.55
.....	7,020	239	1,077	1.75	1.95
.....	8,670	654	2,018	3.28	3.78
-15	2,190	1,110	1,548	2.52	1.40

Estimated monthly discharge of Pemigewasset River at Plymouth, N. H., 1886–1904—Continued.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1890.					
April 15–30	8,970	3,620	5,714	9.29	5.18
May	17,510	2,270	6,619	10.76	12.41
June	3,770	710	1,690	2.75	3.07
July	7,495	395	1,154	1.88	2.17
August	10,680	270	1,671	2.72	3.14
September	15,410	900	3,302	5.37	5.99
October	7,210	964	2,101	3.42	3.94
November 1–15	1,857	1,110	1,360	2.21	1.24
1891.					
April 15–30	15,410	3,100	8,380	13.63	7.60
May	4,560	1,335	2,705	4.40	5.07
June	2,350	493	1,190	1.93	2.15
July	3,415	305	783	1.27	1.46
August	3,100	270	809	1.32	1.52
September	1,335	185	515	.837	.934
October	593	165	234	.380	.438
November 1–15	1,940	145	421	.685	.382
1892.					
April 15–30	2,618	900	1,467	2.39	1.33
May	7,020	1,407	3,277	5.33	6.13
June	10,170	497	2,290	3.72	4.15
July	9,670	270	1,695	2.76	3.18
August	6,290	185	1,211	1.97	2.27
September	9,670	350	1,029	1.67	1.86
October	710	327	466	.755	.870
November 1–15	3,920	545	1,385	2.25	1.25
1893.					
April 15–30	5,230	2,020	2,923	4.75	2.65
May	17,200	1,488	7,117	11.57	13.34
June	2,805	395	958	1.56	1.74
July	395	165	241	.392	.452
August	6,925	165	692	1.13	1.30
September	1,560	270	619	1.01	1.13
October	6,925	270	1,648	2.68	3.09
November 1–15	1,785	497	864	1.41	.787

onthly discharge of Pemigewasset River at Plymouth, N. H., 1886–1904—Continued.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1894.					
.....	18,560	2,805	6,513	10.59	5.91
.....	14,680	654	2,519	4.10	4.73
.....	6,290	497	1,380	2.24	2.50
.....	766	165	419	.681	.785
.....	270	145	170	.276	.318
.....	4,400	145	598	.972	1.08
.....	2,530	209	635	1.03	1.19
-15.....	4,560	545	1,337	2.17	1.21
1895.					
.....	13,730	3,415	6,432	10.46	5.84
.....	6,290	710	2,313	3.76	4.33
.....	1,785	395	845	1.37	1.53
.....	710	209	388	.631	.728
.....	1,182	239	469	.763	.880
.....	710	185	294	.478	.533
.....	2,190	305	677	1.10	1.27
-15.....	5,400	545	1,457	2.37	1.32
1896.					
.....	18,560	2,530	7,986	12.99	7.25
.....	2,618	593	1,358	2.21	2.55
.....	1,632	239	716	1.16	1.29
.....	3,285	185	497	.808	.932
.....	1,335	239	493	.802	.925
.....	6,290	270	1,298	2.11	2.35
.....	11,210	545	1,738	2.83	3.26
-15	19,610	900	3,560	5.79	3.23
1897.					
.....	13,840	3,220	7,497	12.19	6.80
.....	22,240	1,335	4,085	6.64	7.66
.....	13,420	900	2,658	4.32	4.83
.....	30,640	654	3,878	6.31	7.27
.....	1,335	395	698	1.13	1.30
.....	443	185	259	.421	.470
.....	2,530	165	363	.590	.680
-15	5,840	209	1,493	2.43	1.36

Estimated monthly discharge of Pemigewasset River at Plymouth, N. H., 1886–1904—Continued.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1898.					
April 15–30	11,420	3,100	5,395	8.77	4.89
May	14,360	2,020	3,460	5.63	6.49
June	4,160	710	1,517	2.47	2.76
July	654	156	290	.472	.544
August	766	145	302	.491	.566
September	1,182	145	341	.554	.618
October	7,685	270	1,122	1.82	2.11
November 1–15	2,340	654	1,147	1.87	1.04
1899.					
April 15–30	14,880	4,805	9,448	15.36	8.57
May	16,140	964	3,680	5.98	6.89
June	1,182	239	458	.745	.831
July	836	185	317	.516	.595
August	497	132	197	.320	.369
September	836	120	193	.315	.351
October	2,270	132	307	.499	.575
November 1–15	3,220	185	788	1.28	.713
1900.					
April 15–30	19,610	4,000	9,870	16.05	9.25
May	13,000	1,560	3,953	6.42	7.40
June	6,470	209	900	1.46	1.63
July	1,110	185	263	.428	.493
August	900	147	250	.407	.469
September	710	134	215	.350	.390
October	3,770	209	730	1.19	1.37
November 1–15	7,685	239	1,866	3.03	1.69
1901.					
April 15–30	12,780	4,160	6,706	10.90	6.08
May	12,260	1,713	3,895	6.33	7.30
June	2,896	395	1,170	1.90	2.12
July	2,530	270	571	.928	1.07
August	6,290	270	1,016	1.65	1.90
September	395	185	259	.421	.470
October	3,770	209	660	1.07	1.23
November 1–15	710	239	361	.587	.327

' *monthly discharge of Pemigewasset River at Plymouth, N. H., 1886–1904*—Continued.

Month.	Discharge in second feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1902.					
30	6,290	1,940	3,266	5.31	2.96
	12,260	305	3,377	5.49	6.33
	6,290	1,110	2,044	3.32	3.70
	3,220	710	1,431	2.33	2.69
	1,335	365	696	1.13	1.30
er	4,560	305	1,128	1.83	2.04
	18,560	766	2,538	4.13	4.76
r 1–15	2,350	1,110	1,617	2.63	1.47
1903.					
30	3,100	350	1,729	2.81	1.56
	3,620	395	1,285	2.09	2.41
	10,900	350	2,099	3.41	3.80
	2,896	310	725	1.18	1.36
	2,190	443	758	1.23	1.42
er	497	144	264	.429	.479
	1,605	149	486	.790	.911
r	710	215	412	.670	.748
r 1–20	940	215	376	.611	.454
1904.					
0	11,420	1,398	4,607	7.49	7.24
	11,840	980	4,741	7.71	8.89
	1,200	282	537	.873	.974
	1,020	149	338	.550	.634
	5,400	215	594	.966	1.11
er	6,470	149	1,045	1.70	1.90
	7,780	545	1,522	2.47	2.85
r	876	340	554	.901	1.01
r	515	232	372	.605	.698

CONTOOCOOK RIVER AT WEST HOPKINTON, N. H.

station was established July 9, 1903, by H. K. Barrows. It is at the wooden highway bridge near the railway station at West ton. The drainage area at this point is 410 square miles. A d chain gage is attached to the downstream side of the board g of the bridge; length of chain, 26.11 feet. It is referred to

a bench mark on the highest point of the large rock on the south of the road, 15 feet northwest of left abutment; elevation, 21.55 above gage datum. The initial point for soundings is at the do stream side of the left abutment at the top. The channel is stra for 300 feet above and 500 feet below the station, and is about feet wide at ordinary stages. The banks are high and rocky not subject to overflow. The bed is rough and rocky, but perman The current is rapid; the lowest observed mean velocity is 1.20 per second, at gage height 2.42 feet. The gage is read twice daily Frank H. Carr.

The observations at this station during 1904 have been made ur the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Contoocook River at West Hopkinton, N. H., in 1903 and

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Dischs
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second*
July 9	H. K. Barrows	208	1.79	3.00	
July 14	N. C. Grover	179	1.90	2.93	
July 30	H. K. Barrows	178	1.71	2.84	
September 8	do	142	1.55	2.58	
October 7	N. C. Grover	127	1.20	2.42	
1904.					
April 8	N. C. Grover and S. K. Clapp.	556	6.15	5.70	
April 22	S. K. Clapp	443	4.70	4.70	
May 24	do	366	3.67	4.18	
June 7	do	242	2.71	3.36	
August 4	do	164	1.51	2.62	
September 27	T. W. Norcross	160	1.43	2.60	
October 15	do	202	1.47	2.91	
November 4	do	169	1.40	2.68	

ly gage height, in feet, of Contoocook River at West Hopkinton, N. H., for 1904.

y.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	5.55	7.80	3.50	3.65	3.00	2.60	3.35	2.90	[a] 3.75
.....	.....	6.30	6.80	3.45	4.00	2.80	2.70	3.25	2.90	[a] 3.70
.....	.....	6.70	6.25	3.40	3.90	2.70	2.65	3.05	2.90	[a] 3.70
.....	.....	6.15	5.30	3.40	3.60	2.80	2.70	3.00	2.90	[a] 3.70
.....	.....	5.70	4.90	3.40	3.20	2.80	2.70	3.00	2.90	([b])
.....	.....	5.60	4.50	3.40	3.15	2.70	2.65	2.90	2.90	.....
.....	.....	5.80	4.30	3.60	3.10	2.70	2.65	2.90	2.85	.....
.....	.....	6.00	4.20	3.80	3.10	2.70	2.70	2.90	2.80	.....
.....	.....	6.35	4.10	3.70	3.00	2.70	2.70	2.80	2.85	.....
.....	.....	7.70	4.30	3.55	2.95	2.60	2.70	2.80	2.80	.....
.....	.....	8.15	5.00	3.40	2.90	2.80	2.60	2.75	2.80	.....
.....	.....	7.15	5.10	3.30	2.85	3.40	2.70	2.90	2.80	.....
.....	.....	6.30	4.80	3.15	2.85	3.25	2.70	3.00	2.80	.....
.....	.....	5.85	4.40	3.10	2.80	3.10	2.60	3.10	2.80	.....
.....	.....	5.40	4.20	3.20	2.80	2.90	3.80	3.10	2.90	.....
.....	.....	5.15	4.50	3.10	2.75	2.80	4.80	3.10	3.05	.....
.....	.....	5.00	4.50	3.10	2.75	2.75	4.55	3.00	3.10	.....
.....	.....	5.00	4.30	3.00	2.80	2.65	3.85	2.80	3.10	.....
.....	.....	5.20	5.00	3.00	2.80	2.60	3.50	2.80	3.15	.....
.....	.....	5.30	6.20	2.90	2.80	2.70	3.15	2.90	3.00	.....
.....	.....	5.10	5.85	2.90	2.85	3.35	3.05	3.00	3.10	.....
.....	.....	4.90	5.30	2.90	2.80	3.60	2.90	3.60	3.20	.....
.....	.....	4.70	4.80	2.90	2.80	3.30	2.80	3.80	3.20	.....
.....	.....	4.50	4.40	2.95	2.75	3.00	2.80	3.55	3.30	.....
.....	.....	4.55	4.20	2.95	2.80	2.90	2.80	3.35	3.30	.....
.....	.....	4.50	4.20	2.90	2.80	2.80	2.80	3.25	3.20	.....
.....	12.70	4.50	4.20	2.90	2.90	2.80	2.80	3.20	3.20	.....
.....	10.90	6.00	4.05	2.80	2.90	2.70	2.85	3.15	[a] 3.40	.....
.....	8.50	8.70	3.80	2.75	2.90	2.70	2.85	3.00	[a] 3.70	.....
.....	6.85	9.30	3.65	3.00	2.90	2.60	3.10	3.00	[a] 3.60	.....
.....	6.25	.....	3.55	.....	2.80	2.60	.....	2.90	.....	.....

[a] Anchor ice affects gage heights.
[b] River frozen over. Gage not read during frozen season.

Rating table for Contoocook River at West Hopkinton, N. H., from July 9, 1903, to Decem 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet*
2.5	185	3.6	825	4.7	2,060	5.8	3,580
2.6	220	3.7	915	4.8	2,195	5.9	3,720
2.7	255	3.8	1,005	4.9	2,330	6.0	3,860
2.8	295	3.9	1,100	5.0	2,465	6.1	4,005
2.9	335	4.0	1,200	5.1	2,600	6.2	4,150
3.0	380	4.1	1,310	5.2	2,740	6.4	4,440
3.1	435	4.2	1,420	5.3	2,880	6.6	4,730
3.2	500	4.3	1,540	5.4	3,020	6.8	5,020
3.3	570	4.4	1,660	5.5	3,160	7.0	5,310
3.4	650	4.5	1,790	5.6	3,300		
3.5	735	4.6	1,925	5.7	3,440		

The above table is applicable only for open-channel conditions. It is based u 13 discharge measurements made during 1903 and 1904. It is well defined betw gage heights 2.5 feet and 5.70 feet. The table has been extended beyond these li Above gage height 6 feet the rating curve is a tangent, the difference being 145 tenth.

Estimated monthly discharge of Contoocook River at West Hopkinton, N. H., for 1 and 1904.

[Drainage area, 410 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dep inc
1903.					
July 9–31	1,150	295	489	1.19	1
August	650	210	366	.893	1
September	408	161	240	.585	
October	1,150	170	488	1.19	
November 1–25	1,081	248	396	.966	
1904.					
April	8,645	1,790	3,751	9.15	1
May	6,470	780	2,231	5.44	
June	1,005	275	516	1.26	
July	1,200	275	418	1.02	
August	825	220	340	.829	
September	2,195	220	467	1.14	
October	1,005	275	442	1.08	
November 1–27	570	295	387	.944	

SUNCOOK RIVER AT EAST PEMBROKE, N. H.

This stream enters the Merrimac about 6 miles below Concord and is about 27 miles long, with a total drainage area of about 270 square miles. The drainage basin is hilly and broken; the bed and banks are apt to be rocky. This stream has a large fall, a considerable part of which has been developed.

A gaging station was established at East Pembroke on November 3, 1904, by H. K. Barrows. The drainage area at this point is about 250 square miles. A wooden staff gage is fastened to the abutment of the highway bridge over the canal channel to a mill near this point, which was recently destroyed by fire. This is near the Allenstown station on the Boston and Maine Railroad. At present all of the water, except a slight amount of leakage through the dam, goes through this canal. This is intended as a temporary station, and the gage is read by George P. Cass, of East Pembroke. The records of flow at this point will be published when completed.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

SUDBURY RIVER AT FRAMINGHAM AND LAKE COCHITUATE AT COCHITUATE, MASS.

Sudbury River, a small stream of eastern Massachusetts, receives water from an area west of Framingham. It flows thence in a northerly course through meadows and swamps and joins Assabet River to form Concord River, which in turn continues northerly, entering Merrimac River immediately below the city of Lowell. Storage reservoirs have been constructed by the city of Boston and the Metropolitan Water and Sewerage Board, controlling the greater part of the flow from this basin.

Lake Cochituate drains into Sudbury River a short distance below Framingham. It is controlled as a storage reservoir by the Metropolitan Water Works.

Sudbury River and Lake Cochituate have been studied by the engineers of the city of Boston, the State board of health of Massachusetts, and the Metropolitan Water and Sewerage Board, and records of rainfall in the Sudbury basin have been kept since 1875, and in the Cochituate basin since 1852, but the latter are considered of doubtful accuracy previous to 1872. The records of run-off from 1875 to 1898, inclusive, for Sudbury River, were published in the Twentieth Annual Report, Part IV, and those for Lake Cochituate from 1863 to 1899, inclusive, in Water-Supply and Irrigation Paper No. 35.

The following tables, furnished by Frederic P. Stearns, give the results for 1904; also the averages for thirty years for Sudbury River, and for forty-two years for Lake Cochituate.

Estimated monthly run-off of Sudbury River at Framingham, Mass.

Month.	Run-off.		Rainfall inches.
	Second-feet per square mile.	Depth in inches.	
1904.			
January	0.738	0.851	4
February	1.365	1.472	3
March	4.640	5.349	2
April	5.096	5.685	8
May	2.699	3.112	2
June	.648	.723	2
July	.096	.111	1
August	.262	.303	3
September	.614	.685	6
October	.295	.348	1
November	.447	.499	1
December	.417	.481	2
The year	1.441	19.619	42
1875–1904.			
January	1.882	2.170	4
February	2.879	3.023	4
March	4.620	5.326	[illegible]
April	3.273	3.652	[illegible]
May	1.766	2.036	[illegible]
June	.807	.901	[illegible]
July	.299	.345	
August	.450	.519	
September	.368	.411	
October	.327	.903	
November	1.343	1.500	
December	1.675	1.931	
The year	1.673	22.717	4

Yield and rainfall in Lake Cochituate watershed.

[Drainage area, 18.87 square miles.]

Month.	Total yield in million gallons.	Yield of 1 square mile.		Total rainfall in inches.	Rainfall collected in inches.	Per cent collected.
		Million gallons per day.	Cubic feet per second.			
1904.						
January	343.9	0.588	0.910	4.75	1.05	22.1
February	412.6	.754	1.167	3.11	1.26	40.5
March	1,553.3	2.655	4.108	2.78	4.73	170.4
April	1,717.7	3.034	4.695	8.68	5.24	60.4
May	768.1	1.313	2.032	2.14	2.34	109.5
June	178.8	.316	.489	2.86	.55	19.1
July	22.4	.038	.059	1.80	.07	3.8
August	150.6	.257	.398	3.32	.49	14.8
September	329.5	.582	.901	6.78	1.00	14.8
October	137.8	.236	.364	1.66	.42	25.3
November	277.3	.490	.758	1.84	.85	46.0
December	263.9	.451	.698	2.39	.80	33.7
The year.	6,155.9	.891	1.379	42.11	18.80	44.6
1863–1904.						
January	27,622.0	1.124	1.739	165.60	2.01	50.9
February	35,927.9	1.606	2.484	169.39	2.61	64.7
March	54,884.1	2.234	3.455	186.91	3.98	89.5
April	41,312.8	1.738	2.688	155.31	3.00	81.1
May	24,495.9	.997	1.543	156.57	1.78	47.7
June	11,124.8	.468	.691	126.51	.81	26.8
July	7,329.6	.298	.462	173.60	.53	12.9
August	10,469.7	.426	.659	185.03	.76	17.3
September	10,031.9	.422	.653	147.27	.73	20.8
October	14,298.3	.582	.376	185.03	1.04	23.6
November	19,485.2	.820	1.268	175.20	1.42	33.9
December	23,651.8	.963	1.489	148.95	1.72	48.4
The year.	280,634.0	.970	1.500	1,975.37	20.38	43.3

Yield, in cubic feet per second per square mile, of Lake Cochituate watershed, 1900–1904.[a]

[Drainage area, 18.87 square miles.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1900	1.060	4.136	4.020	1.454	1.641	0.455	0.293	0.558	0.640	0.689	1.087	1.502	1.445
1901	.840	.629	3.845	4.649	3.704	1.019	.792	1.101	1.012	1.083	1.034	3.675	1.959
1902	2.071	1.934	6.022	2.741	.955	.319	.398	.604	.688	.814	.710	2.052	1.612
1903	2.184	2.734	4.311	3.106	.689	2.132	.553	.408	.130	.886	.534	.815	1.531
1904	.910	1.167	4.108	4.695	2.032	.489	.059	.398	.901	.364	.758	.698	1.379

[a] Corrected for water drawn from Dudley Pond.

NASHUA RIVER (SOUTH BRANCH) AT CLINTON, MASS.

Since July, 1896, the flow of the South Branch of Nashua River has been measured at Clinton by the engineers of the Metropolitan Water and Sewerage Board. The results of these measurements have been furnished by Frederic P. Stearns, chief engineer. A large storage reservoir is now being constructed at Clinton, Mass. Water was stored to an appreciable extent in this reservoir during 1903. Beginning with 1897 the flow has been corrected for loss and gain of storage in ponds and mill reservoirs on the watershed, so that the results show the natural flow of the stream. The following tables give the results for 1904, also the average for the years 1897–1904, inclusive.

Yield and rainfall in Nashua River (South Branch) Watershed.

[Drainage area, 119 square miles.]

Month.	Total yield in million gallons.	Yield of 1 square mile.		Total rainfall in inches.	Rainfall collected in inches.	Per cent collected.
		Million gallons per day.	Cubic feet per second.			
1904.						
January	2,432.6	0.659	1.020	4.02	1.176	29.3
February	3,198.7	.927	1.434	2.66	1.547	58.1
March	11,094.8	3.008	4.653	3.40	5.361	157.7
April	10,654.1	2.984	4.617	7.45	5.149	69.1
May	5,524.5	1.498	2.317	2.99	2.671	89.3
June	2,719.8	.762	1.179	3.44	1.315	38.2
July	1,832.5	.497	.769	3.84	.886	23.1
August	1,309.1	.355	.549	3.68	.633	17.2
September	1,763.7	.494	.764	5.30	.853	16.1
October	1,281.9	.347	.538	1.78	.620	34.8
November	1,222.9	.343	.530	1.62	.591	29.0
December	1,621.5	.440	.680	2.88	.784	27.2
The year	44,656.1	1.025	1.550	43.06	21.586	50.2
1897–1904.						
January	34,554.1	1.171	1.811	28.94	2.088	57.7
February	41,853.9	1.563	2.418	33.09	2.530	61.2
March	94,026.6	3.186	4.930	40.29	5.683	112.8
April	74,906.4	2.623	4.058	36.00	4.528	100.6
May	39,191.8	1.328	2.054	27.60	2.369	68.7
June	26,547.5	.929	1.438	35.15	1.605	36.5
July	15,625.2	.530	.819	35.48	.944	21.3
August	15,828.9	.536	.830	36.55	.957	20.9
September	10,218.0	.358	.553	28.24	.617	17.5
October	18,124.6	.614	.397	30.04	1.095	29.2
November	24,581.8	.861	.556	30.15	1.486	39.4
December	46,998.0	1.593	2.464	39.01	2.840	58.3
The year	442,456.8	1.273	1.969	400.54	26.742	53.4

Yield, in cubic feet per second per square mile, of Nashua River (South Branch) watershed, 1897–1904.

[Drainage area, 119 square miles.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1897....	1.232	1.440	4.270	2.525	1.800	1.828	2.231	1.386	0.528	0.377	1.984	3.521	1.938
1898....	2.418	2.530	4.778	3.137	2.151	1.281	.514	2.049	1.045	2.334	3.358	3.189	2.400
1899....	3.236	1.687	4.295	5.224	1.344	.869	.548	.365	.387	.379	.665	.555	1.626
1900....	1.232	6.271	5.759	2.444	2.139	.894	.336	.304	.197	.437	1.354	2.429	1.956
1901....	.803	.551	4.205	7.711	4.222	1.525	.738	.792	.495	1.001	.799	5.002	2.332
1902....	2.579	2.168	6.176	3.341	1.595	.685	.452	.459	.372	1.471	.982	2.859	1.930
1903....	1.957	3.300	5.297	3.463	.880	3.297	.966	.734	.580	1.065	.981	1.476	1.988
1904....	1.020	1.434	4.653	4.617	2.317	1.179	.769	.549	.764	.538	.530	.680	1.550

BLACKSTONE RIVER DRAINAGE BASIN.

Blackstone River rises in Worcester County, near the city of Worcester, flowing in a southeasterly course and emptying into Providence River at Providence, below Pawtucket, where it is generally known as Seekonk River. It has always been important as a water-power stream, and has been very fully developed in this way. There are no large lakes in the basin but numerous small ponds and reservoirs used for storage, and the flow of the river is quite constant. It has numerous tributaries, all of which, though small, are utilized for power purposes.

A gaging station was maintained by the United States Geological Survey at Berkeley, R. I., from May, 1901, through the year 1902, and records obtained at this point may be found in Water-Supply and Irrigation Papers Nos. 65 and 82. This station has been discontinued, owing to backwater influence from dams and generally unsatisfactory conditions. The United States Geological Survey maintains a gaging station on Blackstone River at the present time at Woonsocket, R. I.

BLACKSTONE RIVER AT WOONSOCKET, R. I.

This station was established April 5, 1904, by N. C. Grover. It is located at "River Street Bridge," about midway between the railroad station at Woonsocket, R. I., and that of Blackstone, Mass., being 1½ miles from either of these two points. The drainage area at this point is 360 square miles. It is about 1 mile below the dam at Blackstone and one-half mile above the dam at Woonsocket, and probably the flow is somewhat influenced by this latter.

A standard chain gage is attached to the upstream side of the steel highway bridge; length of chain, 22.57 feet. The gage is referred to bench marks as follows: (1) On the corner of the upstream face of the right abutment; elevation, 18.23 feet above gage datum. (2) A marked point on the bridge near the gage; elevation, 20.26 feet above gage datum. (3) On the upstream face of left abutment; elevation, 18.46 feet above gage datum.

Discharge measurements are made from the 2-span bridge to whi the gage is attached. The initial point for soundings is the face the right abutment on the downstream side. The channel is straig for about 500 feet above and 800 feet below the station. The ban are high, rocky, and clean, and are not subject to overflow. The b of the stream is of rock, gravel, and sand, and free from vegetati The velocity is medium, but well sustained during low water. T gage is read twice daily by Gerald Fitzgerald.

Observations at this station during 1904 have been made under t direction of H. K. Barrows, district hydrographer.

Discharge measurements of Blackstone River at Woonsocket, R. I., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Dischar
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-f*
April 5	N. C. Grover	741	1.82	4.04	1,3
April 5	S. K. Clapp	745	1.95	4.15	1,4
May 6	do	767	2.09	4.05	1,6
June 4	do	610	1.16	3.01	7
June 24	do	613	.95	2.87	5
August 3	do	553	.86	2.56	4
August 20	do	557	.79	2.54	4
September 19	H. K. Barrows	576	.88	2.60	5

Mean daily gage height, in feet, of Blackstone River at Woonsocket, R. I., for 1904

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	D
1		6.0	3.0	2.8	2.6	2.2	2.3	2.4	
2		5.4	3.0	2.8	2.6	2.2	2.0	2.4	
3		4.8	3.0	2.6	2.5	2.2	2.5	2.4	
4		4.3	3.0	2.7	2.6	2.5	2.4	2.4	
5	4.1	4.0	3.0	2.8	2.6	2.5	2.4	2.3	
6	4.0	4.0	3.0	2.8	2.3	2.2	2.4	2.4	
7	3.6	3.6	3.0	2.8	2.6	2.2	2.4	2.3	
8	3.8	3.6	3.2	2.8	2.4	2.2	2.4	2.2	
9	3.8	3.8	3.2	2.2	2.2	2.3	2.4	2.2	
10	5.4	4.4	3.0	2.4	2.2	2.1	2.4	2.2	
11	6.2	4.4	3.0	2.6	2.4	2.5	2.4	2.4	
12	5.2	4.2	2.9	2.8	2.4	2.4	2.4	[a] 1.9	
13	5.0	3.7	3.0	2.8	2.1	2.4	2.6	[a] 1.8	
14	4.6	3.6	2.9	2.7	2.6	2.4	2.6	2.4	
15	4.4	3.5	2.8	2.8	2.6	3.2	2.4	2.5	
16	4.2	3.6	2.8	2.1	2.4	4.2	2.4	2.5	
17	4.2	3.4	2.8	2.6	2.5	3.8	2.4	2.5	
18	4.0	3.3	2.7	2.8	2.4	3.0	2.4	2.6	...
19	3.6	3.4	2.8	2.7	2.4	2.8	2.4	2.6	...
20	3.6	3.6	2.8	2.6	2.2	2.8	2.4	2.6	...
21	3.8	3.4	2.8	2.6	2.8	2.6	2.6	2.5	...

[a] Gage height not true indication of flow as water was drawn down at dam one-half mile belo
[b] River frozen over.

Mean daily gage height, in feet, of Blackstone River at Woonsocket, R. I., for 1904—Con.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
22	3.6	3.4	2.6	2.5	2.7	2.5	2.6	2.6	.....
23	3.3	3.4	2.7	2.4	2.6	2.6	2.4	2.4	.....
24	3.2	3.2	2.8	2.7	2.4	2.6	2.4	2.6	.....
25	3.2	3.2	2.7	2.5	2.5	2.4	2.4	2.4	.....
26	2.9	3.2	2.7	2.6	2.8	2.5	2.5	2.5	.....
27	3.2	3.2	2.8	2.6	2.4	2.5	2.6	2.5	.....
28	6.0	3.0	2.5	2.5	2.6	2.5	2.4	2.6	.....
29	8.7	2.9	2.6	2.6	2.2	2.6	2.1	2.6	.....
30	7.6	2.9	2.8	2.2	2.2	2.3	[a]1.8	2.5	.....
31	.....	3.0	.....	2.6	2.2	.....	2.4	.....	.....

[a] Gage height not true indication of flow as water was drawn down at dam one-half mile below.

THAMES RIVER DRAINAGE BASIN.

This stream drains the eastern part of Connecticut and small portions of Rhode Island and Massachusetts. The country thus included is hilly and contains many natural lakes and ponds which have been improved for reservoir purposes. This is a great manufacturing section, being especially noted for its cotton and woolen industries, and there are many important water-power privileges, both developed and undeveloped.

The Thames is formed at Norwich, Conn., by the union of the Shetucket and Yantic rivers, and at a distance of about 4½ miles from New London enters Long Island Sound. It is a tidal stream below Norwich. A few miles above Norwich Quinnebaug River enters the Shetucket from the east. This stream is the most important tributary of the Shetucket as regards size, storage facilities, etc. It rises in the southern part of Massachusetts in the town of Brimfield, and has a total length of about 60 miles. At Willimantic the Shetucket divides into the Willimantic and Nachaug rivers, which are, especially the former, important water-power streams.

Drainage areas of the Thames and its principal tributaries are given in the following table:

Drainage areas of Thames River and its principal tributaries.

River.	Locality.	Area.
		Square miles.
Thames	Norwich	1,300
Do	New London	1,400
Willimantic	Mouth	223
Nachaug	do	169
Quinnebaug	do	688
Shetucket	do	1,200
Yantic	do	98

The United States Geological Survey maintains a gaging station on Shetucket River a short distance below Willimantic, Conn.

SHETUCKET RIVER NEAR WILLIMANTIC, CONN.

This station was established April 4, 1904, by N. C. Grover. It is located at the highway bridge (locally known as Bingham Bridge), about 1 mile below Willimantic and 1 mile below the junction of Willimantic and Nachaug rivers. The drainage area at this point is 396 square miles. A standard chain gage is attached to the downstream side of the bridge near the center of the left span; length of chain, 22.49 feet. The gage is referred to bench marks as follows: (1) Marked point on bridge near the gage scale; elevation, 21.46 feet. (2) Top of left abutment on the downstream corner; elevation, 21.76 feet. (3) Top of face of right abutment on the downstream corner; elevation, 21.19 feet. (4) Top of downstream point of the pier; elevation, 19.77 feet. All elevations are referred to gage datum.

Discharge measurements are made from the 2-span steel bridge, total length 200 feet, to which the gage is attached. The initial point for soundings is the extreme outer edge of the end column of the downstream truss at the left bank. The channel is straight for about 800 feet above and below the station, and there are two channels at all stages. The banks are high, rocky, and clean, and not subject to overflow. The bed of the stream is of rock and permanent. Current is swift at all stages. The gage is read twice daily by Mrs. John Houle.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Shetucket River near Willimantic, Conn., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 4	N. C. Grover	689	2.32	4.78	1,600
May 5	S. K. Clapp	608	2.13	4.15	1,290
June 3	do	420	1.38	3.00	580
June 23	do	380	.84	2.54	320
August 2	do	392	1.13	2.79	443
August 19	do	401	.87	2.62	350
September 19	H. K. Barrows	468	1.16	3.08	54
October 3	T. W. Norcross	427	1.10	2.82	47
October 18	do	410	.97	2.70	40
November 28	do	435	1.13	2.99	49

Daily gage height, in feet, of Shetucket River at Willimantic, Conn., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	5.6	3.1	2.4	1.9	2.2	2.3	2.5	2.5
.....	.....	4.8	3.1	2.2	2.8	2.1	2.4	2.4	2.5
.....	.....	4.6	3.0	2.2	2.7	2.2	2.8	2.6	2.0
.....	5.0	4.3	3.0	2.2	2.5	1.8	2.2	2.5	2.6
.....	4.5	4.1	2.8	2.4	2.8	1.6	2.2	2.4	2.4
.....	4.2	3.7	2.7	2.5	2.6	2.2	2.3	2.0	2.2
.....	4.3	3.5	2.7	2.4	2.4	2.2	2.2	2.6	2.4
.....	4.6	3.6	2.8	2.4	2.9	2.4	2.7	2.4	2.4
.....	4.6	4.2	3.0	2.3	2.4	1.8	2.4	2.5	2.2
.....	7.6	4.4	3.0	2.3	2.6	2.0	2.9	2.6	2.4
.....	6.8	4.5	2.8	2.3	3.6	2.2	2.4	2.3	1.9
.....	5.8	4.1	2.7	2.3	3.4	2.1	2.4	2.2	3.2
.....	5.6	3.7	2.4	2.3	2.8	2.2	2.8	2.4	2.7
.....	5.0	3.4	2.6	2.3	2.4	1.9	3.1	3.9	2.6
.....	4.6	3.5	2.6	2.3	2.5	5.2	2.9	3.8	2.3
.....	4.6	3.9	2.6	2.4	2.5	6.2	2.6	3.4	3.8
.....	4.9	4.2	2.5	1.7	2.1	4.0	3.0	3.0	3.8
.....	4.5	3.9	2.5	2.1	2.4	3.2	2.6	3.0	[a]2.9
.....	4.2	3.6	1.9	2.1	2.4	3.0	2.8	2.6	[b]2.4
.....	4.0	3.8	2.2	2.0	2.3	2.9	2.4	2.4	[c]1.6
.....	4.0	3.5	2.2	2.0	3.7	2.6	2.7	2.8	[d]1.8
.....	3.8	3.3	2.2	2.0	3.8	2.6	3.8	2.8	[b]2.5
.....	3.6	3.2	2.2	2.0	3.2	2.0	3.4	2.8	[e]2.6
.....	3.5	3.1	2.2	1.7	3.1	2.2	3.0	2.6	[d]2.4
.....	3.6	3.0	2.2	2.2	2.4	2.5	3.0	2.6	[d]2.4
.....	3.6	3.0	1.7	2.5	2.3	2.2	2.8	2.3	[b]2.9
.....	3.8	3.0	2.2	2.6	1.9	2.6	2.8	2.4	[b]3.6
.....	6.4	3.0	2.2	2.6	1.9	2.6	3.0	2.8	[f]5.8
.....	7.3	2.8	2.2	2.5	2.2	2.6	2.7	2.4	7.0
.....	6.5	2.7	2.2	1.9	2.2	2.4	2.5	2.5	6.6
.....	.....	3.0	.....	1.8	2.3	.....	2.6	.....	4.8

[a] River frozen on December 18.
[b] Ice 0.4 foot thick.
[c] Ice 0.15 foot thick.
[d] Ice 0.25 foot thick.
[e] Ice 0.35 foot thick.
[f] No ice December 28–31.

During frozen season gage heights are to surface of water in hole cut in ice.

CONNECTICUT RIVER DRAINAGE BASIN.

ecticut River has its source in Connecticut Lake, in northern ampshire. Its extreme headwaters, however, lie in the Prov- Quebec and in the mountains on the northern boundary of mpshire; thence the river flows in a southerly direction between ampshire and Vermont and through Massachusetts and Con- ; into Long Island Sound. The total drainage area is 11,085 miles, of which 155 square miles lie in the Province of Quebec. l length from Connecticut Lake to Long Island Sound is 345 On its banks are many cities and towns of importance. It is ral closely followed by one or more railroad lines. Water s used at several points, notably at Windsor locks in Connecti- yoke and Turners falls in Massachusetts, and Bellows Falls and

Wilder in Vermont. The valley of Connecticut River proper is very generally in farm lands. Many of its tributary basins, however, especially in the northern portions, are heavily wooded.

Estimates of the flow of this river at Hartford, Conn., from 1871 to 1885, inclusive, have been published in the Fourteenth Annual Report of the United States Geological Survey, Part II, pages 140–146. Estimates of flow at Holyoke, Mass., from 1880 to 1895, inclusive, have been published in Bulletin No. 140, pages 37–41, and for 1896 and 1897 in the Nineteenth Annual Report, Part IV, page 116. The drainage areas of the river and of several of its tributaries are given in the following table:

Drainage area of Connecticut River and tributaries.

River.	Locality.	Area.
		Square miles.
Connecticut	In Canada	155
Do	Orford, N. H	3,305
Do	Sunderland, Mass	7,700
Do	Hartford, Conn	10,235
Do	Mouth	11,085
Israel	Above South Branch	8.[illegible]
Do	Below South Branch	21.[illegible]
Ammonoosuc	Bretton Woods, N. H	34
Zealand	Mouth	14
Little	do	12
White	Sharon, Vt	680
Ashuelot	Winchester, N. H	385
Deerfield	Mouth	667
Do	Deerfield, Mass	550
Chicopee	Mouth	730
Ware	do	223
Do	Gilbertville, Mass	160
Do	Ware, Mass	162
Quabog	Mouth	213
Do	West Warren, Mass	144
Swift	Mouth	218
Do	West Ware, Mass	18[illegible]
Westfield	Mouth	51[illegible]
Do	Russell, Mass	33[illegible]

United States Geological Survey maintains gaging stations in sin on Connecticut River near Orford, N. H.; on Connecticut at Sunderland, Mass.; on Israel River near Jefferson Highlands, on Ammonoosuc River at Bretton Woods, N. H.; on Zealand near Twin Mountain, N. H.; on Little River near Twin Moun-. H.; on White River at Sharon, Vt.; on Ashuelot River at ester, N. H.; on Deerfield River at Deerfield, Mass.; on Ware near Ware, Mass.; on Quabog River near West Warren, Mass.; stfield River at Russell, Mass.

ldition, data regarding flow are obtained at the following places, h the assistance of private parties or corporations: Connecticut at Hartford, Conn.; Ware River at Gilbertville, Mass.; and River at West Ware, Mass.

CONNECTICUT RIVER NEAR ORFORD, N. H.

station was established August 6, 1900, by E. G. Paul. It is at the wooden highway bridge between Orford, N. H., and , Vt., and is about 75 miles from the source of the stream. The ge area at this point is 3,305 square miles. A standard chain attached to the inside timbers of the upper side of the bridge, et from the left abutment; length of chain, 42.95 feet. It is d to bench marks as follows: (1) Top of downstream corner of butment at face; elevation, 30.34 feet. (2) Top of downstream of left abutment at face; elevation, 31.08 feet. (3) Nail in root tree on Orford side, 28.4 feet from southwest corner of bridge 6 feet from produced line of downstream side of bridge; eleva-.11 feet. Elevations are above gage datum. The channel is t for at least 1,000 feet above and 1,000 feet below the station, t 275 feet wide at ordinary stages of the river, and is broken pier. The bed is of gravel and permanent, while the current ng. The gage is read once daily by Frank H. Gardner, of , N. H.

observations at this station during 1904 have been made under ection of H. K. Barrows, district hydrographer.

Rating table for Connecticut River near Orford, N. H. from March 29[a] to November 16, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.0	640	3.8	1,600	7.2	4,780	10.8	9,400
2.1	680	3.9	1,670	7.4	5,000	11.0	9,700
2.2	725	4.0	1,740	7.6	5,220	11.5	10,450
2.3	770	4.2	1,880	7.8	5,440	12.0	11,200
2.4	815	4.4	2,030	8.0	5,660	12.5	11,980
2.5	860	4.6	2,190	8.2	5,900	13.0	12,770
2.6	905	4.8	2,350	8.4	6,140	13.5	13,560
2.7	950	5.0	2,520	8.6	6,380	14.0	14,340
2.8	1,000	5.2	2,700	8.8	6,640	14.5	15,120
2.9	1,050	5.4	2,880	9.0	6,900	15.0	15,910
3.0	1,100	5.6	3,070	9.2	7,160	15.5	16,700
3.1	1,160	5.8	3,270	9.4	7,420	16.0	17,480
3.2	1,220	6.0	3,470	9.6	7,690	16.5	18,260
3.3	1,280	6.2	3,680	9.8	7,970	17.0	19,050
3.4	1,340	6.4	3,900	10.0	8,250	17.5	19,840
3.5	1,400	6.6	4,120	10.2	8,530	18.0	20,620
3.6	1,460	6.8	4,340	10.4	8,810	19.0	22,190
3.7	1,530	7.0	4,560	10.6	9,100		

[a] Take 75 per cent of discharge in table, March 26, 27, and 28, on account of high water due probably to ice gorging; 90 per cent of discharge in table, November 17 to 30 on account of river being covered with thin ice.

The above table is applicable only for open-channel conditions. It is based upon 15 discharge measurements made during 1900 to 1904, inclusive. It is well defined between gage heights 2 feet and 12 feet. The table has been extended beyond these limits. Above gage height 12 feet the rating curve is a tangent, the difference being 157 per tenth. Two estimated and one measured discharge are used as the basis for extending the curve above gage height 12 feet.

m daily gage height, in feet, of Connecticut River near Orford, N. H., for 1904.

y.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	4.3	4.2	4.8	13.9	18.0	7.2	4.1	3.7	3.5	10.4	6.3	4.8
.....	4.2	4.2	4.8	13.4	18.2	6.8	4.0	3.8	3.3	11.7	6.1	.....
.....	4.2	4.2	4.8	13.2	17.4	6.6	4.0	3.8	3.4	11.5	6.1	4.4
.....	4.2	4.1	4.8	11.9	17.2	6.1	4.2	3.6	3.4	11.1	5.9	[a]4.6
.....	4.3	4.1	4.9	10.4	16.6	6.0	4.8	3.5	4.7	10.6	5.8	4.4
.....	4.3	4.1	5.2	9.9	15.1	6.0	4.7	3.4	6.4	9.3	5.8	.....
.....	4.3	[b]4.0	5.2	10.8	14.5	6.3	4.3	3.1	6.3	7.6	5.6	.....
.....	4.0	4.0	5.3	11.4	13.2	7.4	3.9	2.9	5.5	7.4	5.5	.....
.....	4.0	4.1	8.0	13.6	12.0	8.5	3.7	2.6	5.2	7.0	5.4	.....
.....	[c]4.0	4.1	8.3	16.2	12.0	8.1	3.5	2.8	4.8	6.7	5.0	.....
.....	3.9	4.1	7.5	17.6	12.2	7.1	3.6	3.4	4.0	6.7	4.8	[d]4.0
.....	3.8	4.1	6.9	17.2	13.9	6.4	2.8	3.4	4.0	6.5	4.6	.....
.....	3.8	4.1	6.4	15.8	13.1	5.8	2.9	3.6	3.5	7.0	4.4	.....
.....	3.9	[e]4.1	6.1	14.0	11.2	5.4	3.4	3.8	3.5	6.7	4.9	.....
.....	4.0	4.1	6.0	11.6	10.3	5.1	3.9	3.9	4.0	6.6	4.8	.....
.....	4.0	4.2	5.8	10.1	14.0	4.7	4.0	3.8	7.5	6.6	[f]4.8	.....
.....	[g]4.0	4.2	5.6	9.4	16.2	4.6	3.9	4.0	8.0	6.4	[h]4.6	.....
.....	4.0	4.2	5.7	9.6	16.5	4.6	3.9	3.7	7.4	6.2	4.6	[i]3.8
.....	3.9	4.2	5.5	9.4	18.5	4.5	3.1	3.6	6.9	5.9	4.4	.....
.....	3.9	4.2	5.4	8.8	18.2	4.5	3.0	3.8	6.5	5.8	4.3	.....
.....	3.9	[j]4.2	5.4	8.8	17.9	4.4	2.8	4.8	6.4	5.8	5.0	.....
.....	4.0	4.2	5.6	9.0	15.1	3.7	2.7	6.4	7.6	7.6	5.0	.....
.....	4.0	4.3	5.9	9.3	13.0	3.9	2.7	7.2	8.2	8.8	5.2	.....
.....	[k]4.0	4.4	8.4	10.5	11.4	4.0	2.4	6.8	7.1	8.6	5.4	.....
.....	4.0	4.4	8.4	11.8	10.3	4.1	2.5	6.6	6.9	8.0	5.5	[l]3.9
.....	4.1	4.6	[f]13.5	14.8	10.0	4.0	2.6	6.0	8.0	7.9	5.4	.....
.....	4.1	4.7	[f]18.2	15.6	9.5	4.1	2.6	5.2	9.4	7.7	5.0	.....
.....	4.1	[m]4.9	[f]19.1	16.0	9.1	3.5	3.0	4.8	8.7	7.4	4.9	.....
.....	4.2	4.8	[n]17.6	17.5	8.9	4.3	3.4	4.4	7.7	7.4	4.8	.....
.....	4.2	.....	16.0	17.8	8.8	4.1	3.5	3.8	8.4	7.0	4.8	.....
.....	[b]4.2	.....	14.6	.....	8.5	.....	3.6	3.3	.....	6.9	.....	.....

[a] Ice 0.35 foot thick; reading to surface of water, 4.6.
[b] Ice 1.85 feet thick; reading to surface of water, 4.0.
[c] Ice 1.6 feet thick; reading to surface of water, 4.2.
[d] Ice 0.7 foot thick.
[e] Ice 1.9 feet thick.
[f] See rating table note.
[g] Ice 1.7 feet thick; reading to surface of water, 3.8.
[h] River frozen over.
[i] Ice 0.75 foot thick.
[j] Ice 2.2 feet thick.
[k] Ice 1.9 feet thick; reading to surface of water, 3.8.
[l] Ice 1.1 feet thick; reading to surface of water 4.0
[m] Ice 2.1 feet thick.
[n] Ice went out March 29.

.—Gage heights during frozen season to surface of ice except as noted.

Rating table for Connecticut River near Orford, N. H. from March 29[a] to November 16, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.0	640	3.8	1,600	7.2	4,780	10.8	9,400
2.1	680	3.9	1,670	7.4	5,000	11.0	9,700
2.2	725	4.0	1,740	7.6	5,220	11.5	10,450
2.3	770	4.2	1,880	7.8	5,440	12.0	11,200
2.4	815	4.4	2,030	8.0	5,660	12.5	11,980
2.5	860	4.6	2,190	8.2	5,900	13.0	12,770
2.6	905	4.8	2,350	8.4	6,140	13.5	13,560
2.7	950	5.0	2,520	8.6	6,380	14.0	14,340
2.8	1,000	5.2	2,700	8.8	6,640	14.5	15,120
2.9	1,050	5.4	2,880	9.0	6,900	15.0	15,910
3.0	1,100	5.6	3,070	9.2	7,160	15.5	16,700
3.1	1,160	5.8	3,270	9.4	7,420	16.0	17,480
3.2	1,220	6.0	3,470	9.6	7,690	16.5	18,260
3.3	1,280	6.2	3,680	9.8	7,970	17.0	19,050
3.4	1,340	6.4	3,900	10.0	8,250	17.5	19,840
3.5	1,400	6.6	4,120	10.2	8,530	18.0	20,620
3.6	1,460	6.8	4,340	10.4	8,810	19.0	22,190
3.7	1,530	7.0	4,560	10.6	9,100		

[a] Take 75 per cent of discharge in table, March 26, 27, and 28, on account of high water due prob bly to ice gorging; 90 per cent of discharge in table, November 17 to 30 on account of river bei covered with thin ice.

The above table is applicable only for open-channel conditions. It is based up 15 discharge measurements made during 1900 to 1904, inclusive. It is well defin between gage heights 2 feet and 12 feet. The table has been extended beyond the limits. Above gage height 12 feet the rating curve is a tangent, the difference bei 157 per tenth. Two estimated and one measured discharge are used as the basis f extending the curve above gage height 12 feet.

for Connecticut River near Orford, N. H., from January 1 to March 25, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
800	4.65	1,190	5.6	1,820	6.9	2,730
830	4.7	1,220	5.7	1,890	7.0	2,800
860	4.75	1,250	5.8	1,960	7.1	2,870
890	4.8	1,280	5.9	2,030	7.2	2,940
920	4.85	1,310	6.0	2,100	7.3	3,010
950	4.9	1,340	6.1	2,170	7.4	3,080
980	4.95	1,370	6.2	2,240	7.5	3,150
1,010	5.0	1,400	6.3	2,310	7.6	3,220
1,040	5.1	1,470	6.4	2,380	7.7	3,290
1,070	5.2	1,540	6.5	2,450	7.8	3,360
1,100	5.3	1,610	6.6	2,520	7.9	3,430
1,130	5.4	1,680	6.7	2,590	8.0	3,500
1,160	5.5	1,750	6.8	2,660		

ve table is applicable only for ice conditions. It is based upon 12 dis-asurements made during 1903 and 1904 through holes cut in the ice. The of ice varied from 1.2 feet to 2.05 feet. It is well defined between gage eet and 8 feet.

ge heights are to water surface.

ted monthly discharge of Connecticut River near Orford, N. H., for 1904.

[Drainage area, 3,305 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	980	620	765	0.231	0.266
.....	1,220	680	827	.250	.270
.....	19,990	1,160	4,688	1.52	1.75
.....	20,310	6,640	12,320	3.73	4.16
.....	21,400	6,260	13,760	4.16	4.80
.....	6,260	1,400	3,009	.910	1.02
.....	2,350	815	1,416	.428	.493
.....	4,780	905	1,978	.598	.689
.....	7,420	1,280	3,693	1.12	1.25
.....	10,750	3,270	5,542	1.68	1.94
.....	3,790	1,760	2,568	.777	.867
.....	.....	.....	1,375	.416	.480
year	21,400	620	4,328	1.32	16.41

7 to March 25, inclusive, gage heights reduced 0.2 foot to bring them to surface of water surface of ice. This was necessary as ice table was based on gage heights to water cellaneous readings to ice and water showed difference of 0.2 foot.

17 to 30 river covered with thin ice. Discharge obtained by taking 90 per cent of open-

harge for December based upon discharge for seven days scattered through the month. ness of ice the table for ice conditions was not considered applicable. The discharge by taking 88 per cent of the open-channel discharge with gage height to bottom of ice.

CONNECTICUT RIVER AT SUNDERLAND, MASS.

This station was established March 31, 1904, by N. C. Grov is located at a 5-span steel highway bridge, total length being 830 feet, at Sunderland, Mass. The nearest railway station is a: Deerfield, Mass. The gaging station is about 18 miles above tl at Holyoke and about 5 miles below that of Turners Falls. The age area at this point is about 7,700 miles. A standard chain ; attached to the downstream side of the bridge near the left length of chain, 42.79 feet. It is referred to bench marks as f (1) On the bottom chord of the bridge near the zero of the gag elevation, 37.82 feet. (2) Corner of left bridge seat at the top downstream face; elevation, 37.06 feet. (3) Northwest corner coping of the downstream end of the pipe culvert, 250 feet ea the left end of bridge; elevation, 32.91 feet. All elevations are r to gage datum.

Discharge measurements are made from the downstream side bridge to which the gage is attached. The initial point for sou is the face of the left abutment at the top on the downstream the bridge. The channel is straight for 1,000 feet above and the station. Both banks are high, rocky, and wooded and not to overflow. The bed of the stream is of gravel, clean, and pern There are 5 channels at all stages. The current is swift at high and medium at low stages. The gage is read twice daily b Lawer.

Observations at this station during 1904 have been made un direction of H. K. Barrows, district hydrographer.

Discharge measurements of Connecticut River at Sunderland, Mass., in 19

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	D
		Square feet.	*Ft. per sec.*	*Feet.*	*S*
April 12	S. K. Clapp	13,550	4.05	17.65	
April 26	do	9,200	3.75	12.15	
May 17	do	7,760	3.32	10.17	
June 2	do	4,110	2.46	5.45	
June 21	do	2,740	1.93	3.45	
July 29	do	2,070	1.77	2.55	
August 18	do	2,000	1.70	2.60	
October 28	T. W. Norcross	5,000	2.60	6.48	
December 1	do	3,090	1.52	4.63	

daily gage height, in feet, of Connecticut River at Sunderland, Mass., for 1904.

ay.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	12.50	19.60	6.35	3.90	3.35	3.10	8.30	5.65	4.60
.....	.....	14.50	17.85	5.50	4.55	2.90	2.90	8.10	5.30	4.60
.....	.....	14.75	16.25	5.50	4.55	2.75	2.65	8.30	5.15	5.15
.....	.....	13.05	15.15	5.35	4.10	3.05	2.40	8.20	5.00	5.50
.....	.....	11.70	14.15	5.10	3.75	3.10	2.35	7.60	4.90	4.90
.....	.....	11.85	13.05	4.90	3.70	2.95	2.85	6.95	4.75	4.70
.....	.....	12.50	12.15	5.50	3.60	2.90	2.85	6.25	4.50	4.80
.....	.....	13.70	11.30	6.10	3.60	2.80	3.80	5.70	4.65	4.70
.....	.....	15.80	10.50	7.50	3.50	2.25	3.85	5.30	4.40	4.70
.....	.....	18.30	10.25	8.00	3.40	2.70	3.60	5.10	4.30	4.50
.....	.....	18.55	10.30	6.85	3.15	3.05	3.40	5.25	4.10	[a] 4.10
.....	.....	17.55	10.90	5.80	3.05	2.90	3.15	5.50	4.00	.....
.....	.....	16.15	11.00	5.15	2.70	2.35	3.00	5.70	3.80	.....
.....	.....	14.65	10.35	5.00	2.85	2.30	2.90	5.60	3.85	.....
.....	.....	12.90	9.30	4.60	2.70	2.20	6.70	5.60	4.10	.....
.....	.....	11.45	9.40	4.30	2.70	1.75	8.70	5.50	4.10	.....
.....	.....	10.40	10.10	4.10	2.70	2.55	7.25	5.10	4.10	[b] 3.80
.....	.....	9.95	10.90	3.90	2.95	2.60	6.80	5.10	3.75	.....
.....	.....	10.20	12.10	3.40	2.85	2.70	6.40	4.85	3.65	.....
.....	.....	10.10	14.65	3.10	2.90	3.05	5.65	4.70	3.80	.....
.....	.....	9.55	15.10	3.20	2.80	5.15	4.90	4.80	3.85	.....
.....	.....	9.25	14.00	3.30	2.55	5.00	4.65	10.20	4.20	.....
.....	.....	9.30	12.40	3.10	2.45	5.10	5.10	9.40	4.75	.....
.....	.....	9.55	10.70	3.05	1.90	5.00	5.50	8.35	4.70	[c] 3.35
.....	.....	10.40	9.40	3.00	2.45	5.10	5.20	7.50	4.60	.....
.....	.....	12.10	8.80	2.95	2.55	4.70	5.05	6.80	4.40	.....
.....	.....	13.25	8.60	3.00	2.40	4.50	6.10	6.30	4.40	.....
.....	.....	16.05	8.10	2.90	2.50	4.10	6.40	6.50	4.35	.....
.....	.....	21.25	7.40	3.05	2.60	3.55	6.40	6.40	4.50	.....
.....	.....	21.40	7.00	3.20	2.70	3.30	6.90	6.05	4.70	.....
.....	13.40	.....	6.85	.....	3.00	3.20	.....	5.80	.....	[d] 5.40

[a] River frozen during night.
[b] Gage height to surface of ice=3.8; ice 0.65 foot thick.
[c] Gage height to surface of ice=3.4; ice 0.90 foot thick.
[d] Gage height is to surface of ice.

CONNECTICUT RIVER AT HARTFORD, CONN.

ly readings of the height of water at Hartford have been led since February 8, 1896, by Edwin Dwight Graves, chief eer Connecticut River bridge and highway district, and through ourtesy have been furnished to the United States Geological y.

se heights are read on what is known as the "Tollhouse gage," ro of which is set at the low-water mark of 1801.[a] The highest ever known in the river was in May, 1854—29 feet 10 inches; west, in 1858—1½ inches below zero.

[a] See report Theodore G. Ellis, 1867 (Ex. Doc. H. R. No. 153, 40th Cong., 2d sess.).

This datum was used in the various surveys of the river below Hartford in 1866–67 (see previous reference); also the survey above Hartford in 1871–1878;[a] also survey of 1897.[b] It is now being used in a further survey of the river above Hartford by an engineer commission appointed by the Secretary of War to study the problem of river improvements above Hartford.

During the low-water periods the tidal wave comes up the river to Hartford. The visible effect of this wave is dependent upon the height of the water and the direction and course of the wind.

From figures given in the Report of the Chief of Engineers for 1878, pages 348–391, and from other data, computations of the discharge of Connecticut River at Hartford from 1871 to 1886, inclusive, were prepared and published in the Fourteenth Annual Report of the United States Geological Survey, Part II, pages 140–146.

Mean daily gage height, in feet, of Connecticut River at Hartford, Conn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.4	3.6	5.2	12.7	19.2	5.4	2.5	1.5	1.9	5.1	4.2	2.5
2	4.3	3.8	5.0	14.1	18.2	5.0	3.8	2.2	2.0	5.7	4.1	2.5
3	3.9	3.5	4.9	15.2	16.7	4.5	3.8	2.5	2.0	5.6	4.0	2.9
4	3.5	3.4	5.7	14.6	15.0	4.2	3.3	2.4	2.0	6.0	4.0	2.6
5	3.9	3.2	6.0	12.7	13.6	3.9	3.0	2.5	1.6	5.7	4.3	2.0
6	3.8	3.4	6.1	11.5	12.3	4.1	2.9	2.6	2.2	5.4	4.1	3.2
7	3.8	3.2	6.5	11.4	11.1	4.5	3.0	2.4	2.7	4.7	3.2	3.1
8	3.8	3.3	11.2	12.0	10.1	5.7	3.0	2.5	2.6	4.3	2.9	3.0
9	4.3	4.0	14.5	13.0	9.5	5.9	2.9	2.4	2.5	3.6	3.0	3.0
10	3.4	3.8	14.8	15.8	9.3	8.2	2.8	2.0	2.5	3.2	3.0	2.9
11	3.5	4.1	13.7	17.4	9.0	7.1	2.6	2.1	1.6	3.5	2.9	2.4
12	4.2	4.3	11.6	17.4	8.8	5.8	2.7	2.1	1.8	3.4	2.5	1.6
13	4.0	4.3	11.0	16.6	9.0	4.9	2.5	2.3	2.1	4.0	2.2	3.4
14	4.1	3.8	9.7	15.3	8.9	4.2	2.0	1.5	2.2	3.9	2.8	3.2
15	3.6	4.0	8.8	13.6	8.3	3.9	2.0	1.2	3.8	3.8	3.2	2.8
16	3.5	4.0	8.0	11.9	7.9	3.7	2.0	2.0	8.9	3.9	3.2	3.2
17	3.1	3.3	7.3	10.5	8.2	3.4	1.5	2.2	8.2	3.8	2.9	3.2
18	2.6	3.2	7.0	9.6	8.6	3.0	1.4	2.0	6.0	3.7	3.5	2.7
19	3.4	3.5	6.9	9.3	9.3	2.4	2.4	1.9	5.1	3.9	3.4	2.4
20	3.4	3.4	6.9	9.3	10.9	2.7	2.4	3.0	4.9	3.7	2.6	3.0
21	3.3	2.7	7.5	9.0	12.6	3.2	2.5	2.3	3.9	4.4	2.7	2.7
22	3.5	3.8	7.1	8.4	12.6	3.2	2.7	3.6	3.0	6.8	3.0	2.3
23	3.8	5.6	6.8	8.0	11.7	2.9	3.1	3.5	3.0	8.4	2.8	2.3
24	3.8	6.0	7.7	7.8	10.3	2.6	2.3	3.2	3.1	7.4	3.5	2.5
25	3.8	6.0	9.7	8.2	8.6	2.5	1.5	3.0	3.4	6.4	3.2	2.0
26	4.4	5.5	11.6	9.0	7.6	2.0	2.0	3.0	3.1	5.6	2.6	1.5
27	4.3	5.5	17.6	10.3	7.3	1.2	1.8	2.5	3.6	4.8	2.2	2.8
28	3.8	4.9	20.0	12.6	7.2	2.1	1.6	2.2	4.0	4.4	2.0	4.0
29	4.0	5.0	18.4	16.3	6.6	2.4	1.7	2.0	4.3	4.6	3.3	4.1
30	4.5	.....	16.0	19.0	5.9	2.2	.9	2.0	4.4	4.3	2.8	4.4
31	3.5	.....	14.1	.....	5.7	.....	1.1	2.3	.....	4.1	.....	4.7

[a] Engineers' Report, 1878, pp. 348–391.

[b] Engineers' Report, 1898, pp. 976–988.

ISRAEL RIVER (ABOVE SOUTH BRANCH) NEAR JEFFERSON HIGHLAN

This station was established September 2, 1903, by N. C. It is located at a small wooden highway bridge in the town dolph, about halfway between the railway stations of Jefferso lands and Bowman, and 2½ miles from either place. The d basin at this point has an area of 8.7 square miles. The hea of the river lie on the slopes of Mount Adams and Mount Je at elevations approximating 5,000 feet. The length of the riv its source to the gaging station is about 5 miles. The elevatio gaging station is about 1,400 feet. All slopes are steep; m precipitous. There is no pondage or artificial storage of wate underlying rock is granite, exposed in the mountain tops. Tl is generally in heavy virgin forest.

A standard chain gage is attached to the upstream truss of the length of chain, 15.43 feet. It is referred to bench marks as (1) Marked point on east end of cross timber of bridge; el 8.58 feet. (2) Top of bowlder, 150 feet east of bridge, 30 fee of river; elevation, 11.99 feet. Elevations are above datum c The channel is straight for 100 feet above and 50 feet below tion, and is about 20 feet wide. The banks are subject to ove extreme freshet. Velocities at low water average about 0.50 c per second. Low-water measurements are made by wading a feet above the bridge. The bed is gravelly and permanent. T is read once daily by E. A. Crawford, of Jefferson Highlands.

The observations at this station during 1904 have been mad the direction of H. K. Barrows, district hydrographer.

Discharge measurements on Israel River (above South Branch) near Jefferson E N. H., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*
eptember 2	H. K. Barrows	14.1	0.67	1.20
eptember 18	do	14.1	.57	1.17
ctober 9	N. C. Grover	12.6	.46	1.15
1904.				
pril 16	N. C. Grover	23	.94	1.44
pril 18	do	24	.92	1.48
ay 1	S. K. Clapp	46	2.18	2.33
ay 11	do	48	2.44	2.35
ay 25	do	29	1.14	1.60
une 15	do	16	.41	1.08
uly 22	do	3.1	1.26	1.04
ugust 10	do	3	1.43	1.04
eptember 24	H. K. Barrows	17	1.04	1.41
ctober 13	T. W. Norcross	17	.75	1.32

Mean daily gage height, in feet, of Israel River (above South Branch) near Jefferson H lands, N. H., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.20	0.80	0.80	1.40	2.35	1.35	1.10	1.20	1.10	1.60	1.45
2	1.20	.80	.80	1.30	2.00	1.30	1.10	1.18	1.32	1.60	1.45
3	1.10	.80	.80	1.30	1.90	1.40	1.45	1.30	1.60	1.60	1.40
4	1.05	.78	.80	1.30	2.10	1.35	1.45	1.30	1.55	1.50	1.35
5	1.00	.78	.80	1.30	2.10	1.30	1.30	1.20	1.50	1.50	1.35
6	a 1.00	.78	.80	1.25	2.00	1.30	1.25	1.15	1.40	1.60	1.35
7	.90	1.80	.80	1.65	2.10	1.45	1.20	1.10	1.40	1.60	1.30
8	.90	2.50	.80	1.60	2.10	1.40	1.15	1.05	1.35	1.60	1.30
9	.85	2.80	.80	1.50	2.00	1.35	1.10	1.00	1.30	1.55	1.25
10	.85	3.00	.80	1.50	1.90	1.30	1.05	1.00	1.30	1.50	1.25
11	.85	2.50	.80	1.50	2.35	1.25	1.00	1.05	1.25	1.50	1.20
12	.85	1.50	.80	1.50	1.80	1.20	.95	1.10	1.20	1.40	1.20
13	.82	1.30	.80	1.70	1.70	1.15	1.20	1.35	1.15	1.35	1.20
14	.82	1.10	2.00	1.70	1.70	1.15	1.10	1.30	1.15	1.30	1.60
15	.82	1.00	3.20	1.50	1.65	1.12	1.08	1.62	2.15	1.30	1.30
16	.80	1.00	3.00	1.45	2.00	1.12	1.05	1.55	1.60	1.30	1.40
17	.80	.95	2.70	1.40	3.20	1.10	1.00	1.50	1.60	1.30	1.60
18	.80	.92	2.40	1.40	2.10	1.10	.98	1.40	1.30	1.30	1.50
19	.80	.90	3.20	1.45	2.25	1.05	.98	1.30	1.20	1.28	1.40
20	.80	.88	4.30	1.45	2.30	1.00	.98	1.25	1.70	1.28	1.60
21	.80	.88	4.00	1.50	2.00	.95	.98	1.68	1.60	1.28	1.60
22	.80	.88	3.40	1.50	2.00	1.35	.95	1.62	1.60	1.25	1.50
23	.80	.88	3.00	1.60	1.80	1.25	.95	1.60	1.50	2.00	1.40
24	.80	.85	4.40	1.68	1.75	1.25	.98	1.55	1.40	1.90	1.20
25	.80	.85	4.80	2.70	1.60	1.30	1.00	1.50	1.60	1.80	1.20
26	.80	.85	4.70	1.70	1.65	1.25	1.20	1.40	1.60	1.70	1.20
27	.80	.82	4.00	1.70	1.65	1.10	1.20	1.30	1.50	1.75	1.60
28	.80	.82	2.00	1.90	1.55	1.10	1.15	1.20	1.40	1.70	1.60
29	.80	.82	1.70	2.90	1.50	1.15	1.18	1.15	2.00	1.60	1.40
30	.80	.....	1.40	2.30	1.45	1.15	1.20	1.15	1.90	1.55	1.20
31	.80	.....	1.40	.....	1.40	.....	1.15	1.10	.....	1.55	.....

a Ice 12 inches—6 solid—6 anchor. b Frozen.

Rating table for Israel River (above South Branch) near Jefferson Highlands, N. H., September 2, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-fee*
0.8	1.0	1.6	30	2.6	158	3.6	338
.85	1.2	1.7	38	2.7	176	3.7	356
.9	1.6	1.8	46	2.8	194	3.8	374
.95	2.2	1.9	55	2.9	212	3.9	392
1.0	3.0	2.0	67	3.0	230	4.0	410
1.1	5.3	2.1	79	3.1	248	4.2	446
1.2	8.6	2.2	93	3.2	266	4.4	482
1.3	13	2.3	108	3.3	284	4.6	518
1.4	18	2.4	124	3.4	302	4.8	554
1.5	24	2.5	140	3.5	320		

The foregoing table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 1.04 feet and 2.40 feet. The table has been extended beyond these limits. Above gage height 2.50 feet the rating curve is a tangent, the difference being 18 per tenth.

Estimated monthly discharge of Israel River (above South Branch) near Jefferson Highlands, N. H., for 1903 and 1904.

[Drainage area, 8.7 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
September 2-30	8.6	4.8	6.09	0.700	0.755
October	29	4.8	9.28	1.07	1.23
November 1-17	17	4.8	8.70	1.00	.632
1904.					
March 14-31	554	18	259	29.77	19.93
April	212	13	39	4.48	5.00
May	266	18	66	7.59	8.75
June	21	2.2	10.1	1.16	1.29
July	21	2.2	6.46	.743	.857
August	36	3.0	14.3	1.64	1.89
September	86	5.3	24.7	2.84	3.17
October	67	10.6	26.4	3.03	3.49
November	30	8.6	17.5	2.01	2.24
December 1-17	8.6	5.3	6.85	.787	.498

NOTE.—Ice conditions November 18, 1903, to March 13, 1904, and December 18-31, 1904.

ISRAEL RIVER (BELOW SOUTH BRANCH) NEAR JEFFERSON HIGHLANDS, N. H.

This station was established September 2, 1903, by N. C. Grover. It is located at a small wooden highway bridge about 2 miles from the railway station at Jefferson Highlands, in the town of Jefferson. The drainage basin at this point is 21.2 square miles. South Branch of Israel River has its mouth above this station and below the station previously described. South Branch drains an area of 10.5 square miles; its headwaters are on the slopes of Mount Jefferson and Mount Dartmouth, at elevations of 3,000 to 5,000 feet. The extreme length from its source to its mouth is about 5 miles. The elevation at its mouth is about 1,350 feet. As all the slopes are steep there is little or no storage of water. The underlying rock is granite, exposed in

the mountain peaks. The basin has been generally "hard cut," a lumbermen say, but has not been burned.

A standard chain gage is attached to the downstream side o truss of the bridge; length of chain, 12.99 feet. It is referr bench marks as follows: (1) Marked point on center cross timl bridge; elevation, 8.14 feet. (2) Top of bowlder 50 feet nor bridge, 15 feet west of highway; elevation, 5.20 feet. Elevatior above datum of gage. The channel is straight for 100 feet abov 100 feet below the station, and is about 20 feet wide. The b rough and rocky, but permanent. The banks are subject to ove in extreme freshets. At extreme low water the mean velocity obs was 0.79 feet per second. Depths average at low water about 1 Gage is read once daily by E. A. Crawford, of Jefferson Highla

The observations at this station during 1904 have been made u the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Israel River (below South Branch) near Jefferson Hig N. H., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Dis
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Seco*
September 2	H. K. Barrows	13.3	1.35	1.13	
September 18	do	12.3	1.21	1.10	
October 9	N. C. Grover	10.4	1.11	1.03	
1904.					
April 16	N. C. Grover	16	2.55	1.43	
April 18	do	18	2.87	1.49	
April 30	S. K. Clapp	64	4.75	2.55	
May 1	do	54	4.29	2.28	
May 11	do	57	4.80	2.40	
May 25	do	24	3.33	1.64	
June 15	do	12	1.25	1.09	
July 22	do	10.4	.79	.94	
August 10	do	11.5	.82	1.00	
September 24	H. K. Barrows and T. W. Norcross.	18.5	1.99	1.40	
October 13	T. W. Norcross	17	1.63	1.36	
November 18	do	27	.89	1.98	

Mean daily gage height, in feet, of Israel River (below South Branch) near Jefferson Highlands, N. H., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	0.85	0.85	1.40	2.35	1.35	1.10	1.20	1.10	1.60	1.45	1.80
2	1.40	.85	.85	1.35	2.00	1.30	1.10	1.15	1.30	1.60	1.45	1.70
3	1.10	.82	.82	1.35	1.90	1.40	1.45	1.30	1.60	1.60	1.40	1.60
4	1.08	.82	.82	1.35	2.10	1.35	1.40	1.30	1.50	1.60	1.35	1.60
5	1.00	.82	.82	1.30	2.10	1.30	1.30	1.20	1.50	1.50	1.35	1.40
6	[a] 1.00	.82	.82	1.30	1.90	1.30	1.25	1.10	1.45	1.50	1.35	1.20
7	.95	[b] 1.90	.82	1.70	2.10	1.45	1.20	1.05	1.45	1.60	1.30	1.20
8	.92	2.70	.80	1.60	2.00	1.40	1.15	1.05	1.40	1.60	1.30	1.20
9	.90	3.30	.80	1.60	1.90	1.35	1.10	1.00	1.35	1.55	1.30	1.15
10	.90	3.00	.80	1.50	1.90	1.30	1.05	1.00	1.30	1.50	1.28	1.15
11	.90	2.10	.80	1.50	2.40	1.25	1.00	1.10	1.25	1.50	1.25	1.15
12	.90	1.20	.80	1.50	1.85	1.20	.95	1.10	1.20	1.40	1.25	1.15
13	.88	1.20	.80	1.70	1.75	1.15	1.20	1.30	1.15	1.35	1.22	1.15
14	.88	1.10	2.40	1.70	1.70	1.15	1.10	1.20	1.15	1.30	1.65	1.15
15	.88	1.00	3.50	1.50	2.05	1.12	1.08	1.60	2.22	1.30	1.40	1.15
16	.85	1.00	3.40	1.45	2.10	1.12	1.05	1.50	1.60	1.28	1.20	1.15
17	.85	.90	3.00	1.40	3.25	1.10	1.00	1.40	1.60	1.28	1.60	1.15
18	.85	.90	3.70	1.40	2.05	1.10	.98	1.30	1.35	1.28	1.95	(c)
19	.85	.90	3.70	1.45	2.30	1.05	.98	1.20	1.20	1.25	1.90	.....
20	.85	.90	3.70	1.45	2.35	1.00	.98	1.15	1.70	1.25	1.60	.....
21	.85	.90	4.40	1.50	2.10	.95	.98	1.70	1.60	1.25	1.40	.....
22	.85	.88	4.20	1.50	2.00	1.35	.95	1.60	1.50	2.00	1.20	.....
23	.85	.88	3.70	1.60	1.80	1.30	.95	1.60	1.40	2.00	1.20	.....
24	.85	.88	3.00	1.70	1.70	1.25	.98	1.50	1.40	1.92	1.20	.....
25	.85	.88	4.70	2.70	1.65	1.30	1.00	1.40	1.60	1.85	1.20	.....
26	.85	.85	5.20	1.90	1.65	1.25	1.20	1.30	1.60	1.70	1.30	.....
27	.85	.85	5.00	1.80	1.75	1.15	1.20	1.25	1.50	1.70	1.60	.....
28	.85	.85	4.00	1.90	1.55	1.15	1.10	1.20	1.40	1.60	1.90	.....
29	.85	.85	2.20	2.70	1.50	1.10	1.30	1.15	2.05	1.50	1.90	.....
30	.85	.....	1.70	2.30	1.45	1.10	1.20	1.15	1.90	1.50	1.90	.....
31	.85	.....	1.40	.....	1.40	.....	1.15	1.10	.....	1.48	.....	.....

[a] Ice, 14 inches—8 in solid and 6 in anchor ice. [b] Anchor ice affects gage heights. [c] Frozen.

Rating table for Israel River (below South Branch) near Jefferson Highlands, N. H., from September 2, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.8	2.5	1.35	35	2.4	268	3.5	576
.85	3.7	1.4	40	2.5	296	3.6	604
.9	5.3	1.5	52	2.6	324	3.7	632
.95	7.4	1.6	67	2.7	352	3.8	660
1.0	10	1.7	86	2.8	380	4.0	716
1.05	13	1.8	108	2.9	408	4.2	772
1.1	16	1.9	132	3.0	436	4.4	828
1.15	19	2.0	157	3.1	464	4.6	884
1.2	22	2.1	184	3.2	492	4.8	940
1.25	26	2.2	212	3.3	520	5.0	996
1.3	30	2.3	240	3.4	548	5.2	1,052

the mountain peaks. The basin has been generally "l[illegible] however say, but has not been burned.

A standard chain gage is attached to the downstr[illegible] side of the bridge; length of chain, 12.99 feet. I[illegible] bench marks as follows: (1) Marked point on center [illegible] bridge; elevation, [illegible] feet. (2) Top of bowlder 5[illegible] bridge, [illegible] feet west of highway; elevation, 5.20 feet. [illegible] above datum of gage. The channel is straight for 10[illegible] 100 feet below the station, and is about 20 feet wid[illegible] rough and rocky, but permanent. The banks are subj[illegible] in extreme freshets. At extreme low water the mean ve[illegible] was 0.[illegible] feet per second. Depths average at low wate[illegible] Gage is read once daily by E. A. Crawford, of Jefferso[illegible]

The observations at this station during 1904 have be[illegible] the direction of H. K. Barrows, district hydrographer.

[illegible] measurements of Israel River (below South Branch) near J[illegible] N. H., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	[illegible]
		Square feet.	*Ft. per sec.*	[illegible]
1903.				
September 2	H. K. Barrows	13.3	1.35	[illegible]
September 18	do	12.3	1.21	[illegible]
October 9	N. C. Grover	10.4	1.11	[illegible]
1904.				
April 16	N. C. Grover	16	2.55	[illegible]
April 18	do	18	2.87	[illegible]
April 30	S. K. Clapp	64	4.75	[illegible]
May 1	do	54	4.29	[illegible]
May 11	do	57	4.80	[illegible]
May 25	do	24	3.33	[illegible]
June 15	do	12	1.25	[illegible]
July 22	do	10.4	.79	
August 10	do	11.5	.82	[illegible]
September 24	H. K. Barrows and T. W. Norcross.	18.5	1.99	[illegible]
October 13	T. W. Norcross	17	1.63	[illegible]
November 18	do	27	.89	[illegible]

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et.	*Second-feet.*
.65	45
.50	31
48	29
26	15
26	16
4	40
)	89
	467
	634
	627
	499
	123
	43
	18
	23
	67
	44
	118
	62
	28

The foregoing table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 0.94 foot and 2.60 feet. The table has been extended beyond these limits. Above gage height 2.10 feet the rating curve is a tangent, the difference being 28 per tenth.

Estimated monthly discharge of Israel River (below South Branch) near Jefferson Highlands, N. H., for 1903 and 1904.

[Drainage area, 21.2 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
September 2-30	22	7	12.7	0.599	0.646
October	59	10	17.0	.802	.925
November 1-17	30	13	17.7	.835	.528
1904.					
March 14-31	1,052	40	578	27.26	18.25
April	352	30	86.5	4.08	4.55
May	506	40	152	7.17	8.27
June	46	7.4	25.0	1.18	1.32
July	46	7.4	17.4	.821	.946
August	86	10	30.4	1.43	1.65
September	218	16	57.4	2.71	3.02
October	157	26	62.3	2.94	3.39
November	144	22	53.3	2.51	2.80
December 1-17	108	19	35.6	1.68	1.06

NOTE.—Ice conditions November 18, 1903, to March 13, 1904, and December 18 to 31, 1904.

AMMONOOSUC RIVER AT BRETTON WOODS, N. H.

This station was established August 28, 1903, by N. C. Grover. It is located at the steel highway bridge near Mount Pleasant House at Bretton Woods. The drainage area at this point is 34 square miles. The headwaters of the river come from the westerly slopes of Mount Jefferson and Mount Washington and the lesser peaks of the White Mountains lying to the south. The underlying rock is granite, which is exposed at points in the river bed and on the various mountain summits. The slopes and valleys are usually well forested, with a preponderance of evergreen growth. The area was cut in large part for spruce several years ago, but now has a thick forest cover. There is no pondage or artificial storage. The slope of the river is steep.

A standard chain gage is attached to the floor on the downstream side of the bridge; length of chain, 18.86 feet. It is referred to the

following-described bench marks: (1) Marked point on bridge near gage; elevation, 17.36 feet. (2) Northwest corner of east abutment; elevation, 14.46 feet. (3) Top of bowlder 100 feet below bridge, between the river and tracks of Boston and Maine Railroad; elevation, 17.11 feet. Elevations are above datum of gage. Measurements of flow are made from a footbridge located about 300 feet downstream from the gage. The channel is straight for 300 feet above and 200 feet below this bridge, and is about 35 feet wide. The banks are high and not subject to overflow except in extreme freshet. The bed is somewhat rocky, but permanent. Low-water measurements are made by wading about 100 feet above the station, on account of small velocity at the station.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Ammonoosuc River at Bretton Woods, N. H., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
August 28	H. K. Barrows	69.2	0.65	1.65	45
September 2	do	62.0	.50	1.50	31
September 3	do	63.5	.46	1.48	29
September 17	do	45.4	.34	1.26	15
September 17	do	32.0	.49	1.26	16
October 10	N. C. Grover	61.8	.65	1.64	40
1904.					
April 15	N. C. Grover	94	.95	2.00	89
May 2	S. K. Clapp	166	2.81	3.20	467
May 9	do	175	3.62	3.47	634
May 10	do	175	3.58	3.51	627
May 20	do	167	2.99	3.15	499
May 25	do	91	1.35	2.19	123
June 10	do	66	.65	1.60	43
July 21 [a]	do	16	1.12	1.24	18
August 9 [b]	do	17	1.36	1.30	23
August 23	H. K. Barrows	82	.82	1.89	67
August 24 [c]	do	25	1.76	1.67	44
September 25	H. K. Barrows and T. W. Norcross.	94	1.25	2.26	118
October 11	T. W. Norcross	79	.78	1.84	62
November 17	do	62	.46	1.51	28

[a] Measured 400 feet above gage.
[b] Measured 300 feet above gage.
[c] Wading below gage.

Mean daily gage height, in feet, of Ammonoosuc River at Bretton Woods, N. H., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.55	.....	.....	1.85	3.78	1.88	1.40	1.40	1.35	2.75	1.85	1.50
2	1.50	.....	.....	1.90	3.20	1.75	1.78	1.38	1.48	2.55	1.80	1.55
3	.....	.....	2.10	1.90	2.90	1.75	2.02	1.58	1.48	2.40	1.80	1.55
4	1.55	.....	.....	1.90	3.30	1.70	1.65	1.50	1.90	2.20	1.80	1.55
5	.....	.....	1.88	1.88	3.45	1.70	1.62	1.38	1.58	2.10	1.80	1.52
6	.....	[a] 1.40	.....	1.95	2.95	1.70	1.50	1.40	1.50	2.20	1.78	1.50
7	.....	.....	1.70	2.10	3.10	1.72	1.42	1.38	1.48	2.08	1.80	1.50
8	.....	.....	.....	2.60	3.18	1.78	1.38	1.32	1.45	1.72	1.72	1.50
9	1.50	.....	.....	3.35	2.90	1.68	1.35	1.30	1.42	1.90	1.70	[b] 1.45
10	1.50	.....	.....	4.25	3.32	1.60	1.35	1.30	1.40	1.90	1.70	.....
11	1.45	.....	[c] 1.75	2.95	3.50	1.55	1.35	1.48	1.38	1.82	1.58	.....
12	1.45	.....	[c] 1.75	2.55	2.92	1.50	1.35	1.68	1.35	1.78	1.58	.....
13	1.45	[d] 1.35	.....	2.35	2.78	1.50	1.45	1.55	1.40	1.80	1.55	.....
14	1.40	.....	.....	2.05	2.60	1.48	1.38	1.50	1.40	1.80	1.55	.....
15	.....	.....	1.50	2.00	2.92	1.45	1.30	1.75	3.15	1.78	1.55	.....
16	.....	.....	1.50	1.80	3.85	1.42	1.30	1.48	2.20	1.75	1.62	.....
17	1.40	.....	1.55	1.90	4.22	1.40	1.30	1.40	1.80	1.70	1.65	[g] 1.40
18	.....	.....	.....	2.00	2.98	1.40	1.30	1.40	1.80	1.70	1.60	.....
19	.....	[e] 1.40	1.50	2.10	3.35	1.35	1.28	1.35	2.15	1.68	1.58	.....
20	.....	.....	.....	2.10	3.20	1.35	1.25	1.92	1.82	1.65	1.52	.....
21	.....	.....	1.50	2.00	2.82	1.35	1.25	2.30	2.70	3.55	1.58	.....
22	.....	2.50	1.55	2.00	2.58	2.02	1.25	1.82	2.25	3.05	1.60	.....
23	2.10	2.40	2.15	2.02	2.45	1.65	1.25	1.95	1.85	2.48	1.60	.....
24	2.20	2.32	2.40	2.48	2.32	1.48	1.25	1.70	1.92	2.25	1.55	1.35
25	.....	2.15	3.05	3.25	2.22	1.40	1.25	1.58	2.12	2.20	1.50	.....
26	.....	.....	7.60	2.82	2.18	1.68	1.30	1.52	2.00	2.28	1.52	.....
27	.....	[f] 1.50	4.02	3.05	2.25	1.48	1.60	1.50	1.92	2.32	1.62	.....
28	.....	.....	2.32	3.30	2.08	1.45	1.35	1.42	1.82	2.20	1.50	.....
29	1.60	.....	2.00	3.95	1.95	1.40	1.45	1.40	1.90	2.35	1.50	.....
30	.....	.....	2.00	3.75	1.90	1.40	1.42	1.40	2.90	2.00	1.50	.....
31	.....	.....	1.85	.....	1.85	.....	1.35	1.35	.....	1.98	.....	[h] 1.30

[a] Ice 0.65 foot thick. [b] Ice 0.15 foot thick. [c] Ice 0.5 foot thick. [d] Ice 0.85 foot thick. [e] Ice 0.9 foot thick. [f] Ice 0.4 foot thick. [g] Ice 0.6 foot thick. [h] Ice 0.75 foot thick.

NOTE.—Gage heights during frozen season are to surface of water in hole cut in ice under gage. Ice January 1 to March 25, also December 10–31.

Rating table for Ammonoosuc River at Bretton Woods, N. H., from August 28, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.25	15	1.8	58	2.7	238	3.8	820
1.3	18	1.85	63	2.8	277	3.9	880
1.35	21	1.9	68	2.9	318	4.0	940
1.4	24	1.95	74	3.0	365	4.2	1,060
1.45	27	2.0	80	3.1	415	4.4	1,180
1.5	31	2.1	93	3.2	465	4.6	1,300
1.55	35	2.2	108	3.3	520	4.8	1,420
1.6	39	2.3	125	3.4	580	5.0	1,540
1.65	43	2.4	146	3.5	640	5.5	1,840
1.7	48	2.5	172	3.6	700	6.0	2,140
1.75	53	2.6	203	3.7	730		

The foregoing table is applicable only for open-channel conditions. It is based upon 21 discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 1.25 feet and 3.50 feet. The table has been extended beyond these limits. Above gage height 3.30 feet the rating curve is a tangent, the difference being 60 per tenth.

Estimated monthly discharge of Ammonoosuc River at Bretton Woods, N. H., for 1903 and 1904.

[Drainage area, 34 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
September	35	17	23.3	0.685	0.764
October	203	21	42.5	1.25	1.44
November	86	18	34.1	1.00	1.12
December 1-14	96	18	27.0	.794	.413
1904.					
March 26-31	3,100	63	734	21.59	4.82
April	1,090	58	245	7.21	8.04
May	1,072	63	362	10.65	12.28
June	82	21	37.5	1.10	1.23
July	82	15	25.5	.750	.865
August	125	18	35.6	1.05	1.21
September	440	21	80.5	2.37	2.64
October	670	43	123	3.62	4.17
November	63	31	42.5	1.25	1.40
December 1-9	35	27	32.1	.944	.316

ZEALAND RIVER NEAR TWIN MOUNTAIN, N. H.

This gaging station was established August 29, 1903, by N. C. Grover. It is located about 800 feet above the mouth of the river, which empties into the Ammonoosuc at a point midway between Fabyans and Twin Mountain, and about 2½ miles from either place. The drainage basin at this point has an area of 14 square miles. The headwaters lie on the slopes of a spur of the White Mountains at elevations of 2,500 to 3,000 feet. The length of the river from its headwaters to its mouth is about 7 miles, at which point the elevation is approximately 1,500 feet. All slopes within the basin are steep. There is no pondage or artificial storage of water. The underlying rock is granite, which is exposed in the mountain peaks. About ten or twelve years ago this basin was entirely deforested and burned over. At the present time

there is a thick stand of deciduous growth of poplar and bird cherry, averaging 12 to 15 feet in height, which affords a thick covering during the summer months, but practically no cover during the winter and spring. Within the basin we find the usual conditions of this stage of reforestation after a thorough burning.

A standard chain gage is attached to trees on the bank; length of chain, 13.40 feet. It is referred to bench marks as follows: (1) Top of large bowlder under the gage; elevation, 3.56 feet. (2) Drift bolt driven into the maple tree to which the gage is attached; elevation, 11.32 feet. Elevations are above datum of gage. The lowest observed mean velocity has been 0.40 of a foot per second. Low-water measurements are made by wading. The bed is rough and rocky, but permanent. The banks are high and only subject to overflow in extreme freshets. The gage is read once a day by William Cote, of Twin Mountain.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Zealand River near Twin Mountain, N. H., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
August 29 [a]	H. K. Barrows	29.1	0.45	2.01	13.1
September 3 [a]	do	26.6	.40	1.98	10.7
September 18 [a]	do	33.5	.68	2.22	22.9
October 10 [a]	N. C. Grover	35.5	.76	2.29	27
1904.					
April 15	N. C. Grover	25.3	1.88	2.52	47.5
April 30	S. K. Clapp	79	4.09	3.55	323
May 10	do	56	3.25	3.00	182
May 19	do	80	4.60	3.60	368
May 20	do	54	3.37	3.08	182
May 25	do	21	2.10	2.49	44
June 10	do	10	2.10	2.18	21
July 21	do	6.8	1.12	1.88	7.6
August 9	do	8.4	1.49	1.94	12.5
August 23 [a]	H. K. Barrows	40	.95	2.39	38
September 25 [a]	do T. W. Norcross	46	1.48	2.65	68
October 12	do	33	.69	2.21	23

[a] Wading at different sections.

Mean daily gage height, in feet, of Zealand River near Twin Mountain, N. H., for 1904.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	(a)	2.40	3.50	2.40	1.84	1.84	1.74	4.34	3.25	2.35
.....	.....	2.45	3.40	2.40	1.84	1.84	1.94	4.14	3.35	2.45
.....	.....	2.30	3.30	2.30	1.74	1.94	1.94	3.44	2.85	2.45
.....	.....	2.30	3.10	2.20	1.74	1.94	1.84	2.84	2.75	2.75
.....	.....	2.40	3.00	2.20	1.74	2.04	1.84	3.04	2.75	2.75
.....	.....	2.40	3.00	2.10	1.74	1.84	2.04	2.84	2.65	2.55
.....	.....	2.50	2.90	2.10	1.74	1.84	2.04	2.84	2.85	(a)
.....	.....	2.70	2.70	2.10	1.84	1.94	1.94	2.74	2.85	.....
.....	.....	2.70	2.60	2.00	1.84	1.84	1.94	2.44	2.65	.....
.....	.....	3.00	2.60	2.10	1.74	1.84	1.84	2.64	2.75	.....
.....	.....	3.20	2.70	2.10	1.74	1.84	1.84	2.84	2.75	.....
.....	.....	3.00	2.70	2.10	1.94	1.84	1.94	2.84	2.65	.....
.....	.....	2.90	2.60	2.05	1.94	1.74	1.94	2.64	2.85	.....
.....	.....	2.80	2.70	2.00	1.84	1.74	4.34	2.34	2.75	.....
.....	.....	2.70	2.50	2.00	1.84	1.84	3.24	2.24	2.85	.....
.....	.....	2.60	2.50	2.00	1.84	1.84	2.84	2.24	2.85	.....
.....	.....	2.45	2.80	1.95	1.84	1.74	2.34	2.94	2.65	.....
.....	.....	2.40	3.00	2.00	1.74	1.94	2.24	2.84	2.65	.....
.....	.....	2.40	2.90	2.00	1.84	1.94	1.84	2.74	2.65	.....
.....	.....	2.40	2.70	2.00	1.84	1.84	2.24	1.94	2.85	.....
.....	.....	2.30	2.70	2.00	1.84	2.84	2.84	3.84	2.95	.....
.....	.....	2.30	2.50	1.90	1.94	2.24	2.64	4.34	2.95	.....
.....	.....	2.40	2.50	2.10	1.94	2.44	2.34	3.84	2.85	.....
.....	.....	2.50	2.40	2.10	1.84	2.24	2.34	3.74	2.85	.....
.....	.....	2.60	2.40	2.00	1.74	1.94	2.64	3.74	2.85	.....
.....	.....	2.60	2.40	1.90	1.84	1.84	3.84	3.34	2.65	.....
.....	3.00	2.70	2.40	1.90	2.34	1.84	2.84	3.24	2.75	.....
.....	2.70	3.00	2.50	1.90	2.14	1.84	2.84	2.84	2.75	.....
.....	2.50	4.00	2.40	1.90	1.94	1.94	2.64	2.84	2.55	.....
.....	2.50	3.70	2.40	1.90	1.94	1.94	2.24	3.24	2.35	.....
.....	2.40	.....	2.30	.....	1.84	1.84	.....	3.24	.....	.....

a River frozen January 1 to March 26 and December 7-31.

Rating table for Zealand River near Twin Mountain, N. H., from August 29, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.75	4	2.2	22	2.7	82	3.6	368
1.8	5	2.25	25	2.8	109	3.7	402
1.85	6	2.3	28	2.9	139	3.8	436
1.9	8	2.35	31	3.0	170	3.9	470
1.95	10	2.4	35	3.1	202	4.0	504
2.0	12	2.45	40	3.2	234	4.1	538
2.05	14	2.5	45	3.3	266	4.2	572
2.1	16	2.55	52	3.4	300	4.3	606
2.15	19	2.6	61	3.5	334		

The above table is applicable only for open-channel conditions. It is based upon 16 charge measurements made during 1903 and 1904. It is well defined between gage ghts 1.88 feet and 3.60 feet. The table has been extended beyond these limits. Above e height 3.30 feet the rating curve is a tangent, the difference being 34 per tenth.

Estimated monthly discharge of Zealand River near Twin Mountain, N. H., for 1903 a 1904.

[Drainage area, 14 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dep inc
1903.					
September	22	8	10.5	0.750	
October	35	8	17.8	1.27	
November	28	16	23.6	1.69	
December 1–28	45	16	29.0	2.07	
1904.					
March 27–31	170	35	75.4	5.39	
April	504	28	97.9	6.99	
May	334	28	101	7.21	
June	35	8	15.0	1.07	
July	30	4	7.35	.525	
August	121	4	13.0	.929	
September	620	4	76.4	5.46	
October	620	10	213	15.21	
November	283	31	119	8.50	
December 1–6	95	31	58.8	4.20	

LITTLE RIVER NEAR TWIN MOUNTAIN, N. H.

This station was established January 21, 1904, by F. E. Pre It is located at the rough wooden highway bridge about 2 miles s west of Twin Mountain, N. H., and about 2 miles above the ent of this river into Ammonoosuc River. The drainage area at point is about 11 square miles. This drainage basin is adjace that of Zealand River previously described, and practically all f cover has been removed from it. The slopes are steep and the no pondage or artificial storage. This station was established in to obtain comparative data as to the time and duration of freshet few discharge measurements have been made during 1904, but it i intended to make any estimate of discharge for this point, but m a record of gage heights.

A standard chain gage is attached to the floor on the downst side of the bridge above referred to; length of chain, 12.92 feet is referred to bench marks as follows: (1) A marked point o floor of the bridge near the zero of the gage scale; elevation, feet above gage datum; (2) a cross on a bowlder on right bank, 32 feet from end of gage box; elevation, 9.05 feet above gage da

The channel is straight for about 50 feet above and 800 feet below the station. The banks are rocky, low, and clean, and liable to overflow. The bed of the stream is of large bowlders and extremely rough. The current is swift at all stages. The gage is read twice daily by Edward Lynch.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Little River near Twin Mountain, N. H., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
August 23 [a]	H. K. Barrows	26	2.04	5.58	53
September 25 [a]	H. K. Barrows and T. W. Norcross.	32	2.06	5.75	66
October 12 [b]	T. W. Norcross	28	.94	5.30	26

[a] Wading 1 mile below gage. [b] Wading.

Mean daily gage height, in feet, of Little River near Twin Mountain, N. H., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.60	4.70	4.90	6.15	5.20	4.90	5.20	5.00	6.05	5.20	5.10
2	.....	4.65	4.60	4.90	5.70	5.10	5.10	5.05	5.00	5.75	5.20	5.10
3	.....	4.60	5.00	4.90	5.85	5.05	5.35	5.15	5.10	5.65	5.20	5.10
4	.....	4.60	5.85	4.95	6.00	5.10	5.00	5.10	5.30	5.55	5.20	5.10
5	.....	4.65	5.05	5.05	6.10	5.00	5.00	5.10	5.15	5.45	5.20	5.10
6	.....	4.60	4.70	5.05	6.10	5.10	5.00	5.10	5.10	5.55	5.15	5.10
7	.....	5.10	4.65	5.45	6.05	5.00	4.95	5.00	5.10	5.45	5.10	5.10
8	.....	6.05	7.20	5.65	6.00	5.00	4.90	5.00	5.10	5.40	5.10	5.10
9	.....	4.80	5.00	6.15	6.00	5.00	4.90	5.00	5.10	5.35	5.10	5.10
10	.....	4.70	4.95	6.20	5.85	5.00	4.90	5.00	5.00	5.30	[a] 5.25	5.10
11	.....	4.60	4.80	5.80	6.20	5.00	4.90	5.10	5.00	5.30	5.25	5.10
12	.....	4.60	4.80	5.50	5.90	4.90	4.90	5.15	5.00	5.30	5.20	5.10
13	.....	4.60	4.70	5.45	5.85	4.90	5.25	5.10	5.00	5.30	5.10	.....
14	.....	4.60	4.70	5.40	5.85	4.95	5.05	5.00	5.00	5.30	5.10	.....
15	.....	4.60	4.70	5.35	5.95	5.00	5.00	5.20	6.60	5.20	5.10	.....
16	.....	4.60	4.70	5.30	6.50	5.00	5.00	5.10	5.85	5.20	5.10	.....
17	.....	4.60	4.70	5.35	6.25	5.00	4.90	5.10	5.50	5.20	5.10	.....
18	.....	4.60	4.70	5.15	6.05	4.95	4.90	5.10	5.35	5.20	5.40	.....
19	.....	4.60	4.70	5.00	6.20	4.90	4.90	5.00	5.75	5.20	5.45	.....
20	.....	4.60	4.60	5.40	6.15	4.90	4.90	5.90	5.40	5.20	5.15	.....
21	4.65	4.60	4.60	5.15	5.90	4.90	4.80	5.85	5.95	6.20	5.25	.....
22	4.65	6.20	4.65	5.40	5.80	5.05	4.80	5.55	5.55	6.10	5.10	.....
23	5.05	5.00	6.85	5.15	5.70	5.00	4.80	5.75	5.45	5.90	5.10	.....
24	4.85	4.65	5.50	5.35	5.65	5.00	4.80	5.35	5.50	5.55	5.10	.....
25	4.70	4.60	5.70	5.95	5.60	4.90	4.90	5.30	5.75	5.50	5.10	.....
26	4.70	4.60	6.45	5.75	5.60	4.90	4.90	5.25	5.55	5.65	5.10	.....
27	4.70	4.70	5.40	5.55	5.55	4.90	5.10	5.15	5.45	5.55	5.20	.....
28	4.70	4.70	5.25	5.55	5.45	4.90	5.10	5.10	5.40	5.35	5.10	.....
29	4.65	4.70	5.15	6.00	5.30	4.90	5.45	5.10	5.45	5.30	5.40	.....
30	4.60	.....	5.20	6.10	5.25	4.90	5.15	5.05	6.05	5.25	5.10	.....
31	4.60	.....	5.10	.....	5.20	.....	5.00	5.00	.....	5.20	.....	.....

[a] After November 10 gage heights probably affected by anchor ice.

WHITE RIVER AT SHARON, VT.

This station was established June 30, 1903, by H. K. Barrows. It is located at the steel highway bridge near the railway station at Sharon. The drainage area at this point is 680 square miles. A standard chain gage is attached to the upstream truss of the bridge; length of chain, 27.58 feet. It is referred to bench marks as follows: (1) Marked point on post near gage; elevation, 29.96 feet; (2) on south side of east abutment; elevation, 24.59 feet. Elevations are above datum of gage. This station is located above and within the backwater from a crib dam, which is not used for power purposes, all water, except leakage, passing over the crest of the dam. The channel is straight for 500 feet above and 500 feet below the station. It is about 170 feet wide at ordinary stages. The current is sluggish at low water. Measurements at low stages are made by wading at a point about one-half mile above the bridge, where the bed is of gravel and the current swift. The gage is read twice daily by J. M. O'Connor, of Sharon.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of White River at Sharon, Vt., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 30	H. K. Barrows	1,580	0.28	5.03	440
August 1 [a]	do	170	2.32	4.87	395
September 10 [a]	do	140	1.93	4.79	270
1904.					
April 7	N. C. Grover	1,840	1.69	6.63	3,110
May 3	S. K. Clapp	1,820	1.54	6.49	2,810
May 27	do	1,710	.69	5.58	1,180
July 7 [a]	do	62	2.37	4.51	147
July 7 [a]	do	52	2.46	4.49	128
July 27 [a]	do	86	3.67	4.70	316
September 26	T. W. Norcross	1,690	.75	5.59	1,260

[a] By wading.

Mean daily gage height, in feet, of White River at Sharon, Vt., for 1904.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	6.20	7.20	5.20	4.75	4.50	4.50	5.90	6.15	.....
.....	.....	6.15	6.80	5.20	4.80	4.50	4.40	5.90	6.05	.....
.....	.....	.....	6.50	5.15	4.80	4.60	4.40	5.95	5.90	.....
.....	.....	.....	6.40	5.10	4.70	4.60	4.45	5.85	5.75	.....
.....	.....	.....	6.20	5.15	4.70	4.65	4.70	5.75	5.65	.....
.....	.....	.....	6.00	5.20	4.60	4.65	4.80	5.65	5.75	.....
.....	.....	6.80	5.80	5.10	4.55	4.70	4.90	5.55	5.85	.....
.....	.....	6.80	5.70	5.10	4.50	4.70	4.95	5.45	5.90	.....
.....	.....	7.70	5.65	5.05	4.50	(a)	4.95	5.35	5.85	.....
.....	.....	7.60	5.80	5.00	4.60	.....	4.90	5.25	5.75	.....
.....	.....	7.20	5.80	5.00	4.60	.....	4.80	5.15	5.65	.....
.....	.....	6.85	5.65	4.90	4.60	.....	4.80	5.05	5.55	.....
.....	.....	6.70	5.70	4.90	4.70	.....	4.70	4.95	(b)	.....
.....	.....	6.30	5.65	4.90	4.70	.....	4.70	4.85	.....	.....
.....	.....	6.10	5.70	4.80	4.70	.....	4.60	4.80	.....	.....
.....	.....	6.10	5.85	4.80	4.60	.....	5.90	4.85	.....	.....
.....	.....	5.90	5.60	4.75	4.60	.....	5.90	4.95	.....	.....
.....	.....	6.00	5.70	4.70	4.50	.....	5.85	5.05	.....	.....
.....	.....	6.05	6.30	4.80	4.50	4.50	5.75	5.15	.....	.....
.....	.....	6.00	6.20	4.80	4.40	4.60	5.65	5.25	.....	.....
.....	.....	5.90	6.05	4.75	4.35	4.70	5.55	5.50	.....	.....
.....	.....	6.00	6.05	4.75	4.30	4.80	5.45	5.80	.....	.....
.....	.....	6.00	5.75	4.55	4.45	4.80	5.35	6.35	.....	.....
.....	.....	6.10	5.75	4.40	4.50	4.80	5.25	6.75	.....	.....
.....	.....	6.70	5.75	4.50	4.60	4.70	5.15	6.80	.....	.....
.....	.....	6.75	5.70	4.50	4.70	4.70	5.40	6.70	.....	.....
.....	8.05	6.40	5.60	4.40	4.70	4.60	5.60	6.65	.....	.....
.....	6.80	7.30	5.45	4.45	4.70	4.60	5.60	6.55	.....	.....
.....	6.35	8.10	5.40	4.55	4.60	4.60	5.65	6.45	.....	.....
.....	6.25	7.85	5.30	4.60	4.60	4.60	5.80	6.35	.....	.....
.....	6.30	.....	5.30	.....	4.50	4.50	.....	6.25	.....	.....

[a] No gage heights taken from August 9–18, inclusive, on account of repairs to dam.
[b] Frozen over November 13. No records during frozen season.

ible for White River at Sharon, Vt., from July 1, 1903, to December 31, 1904.

t.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
	140	4.9	418	5.6	1,228	6.4	2,645
5	169	4.95	464	5.7	1,370	6.5	2,850
	199	5.0	513	5.8	1,525	6.6	3,055
5	230	5.1	619	5.9	1,695	6.7	3,265
	263	5.2	732	6.0	1,875	6.8	3,475
5	298	5.3	849	6.1	2,060	6.9	3,685
	335	5.4	970	6.2	2,250	7.0	3,900
5	375	5.5	1,095	6.3	2,445		

ove table is applicable only for open-channel conditions. It is based upon 10 e measurements made during 1903 and 1904. It is well defined between gage 4.50 feet and 6.70 feet. The table has been extended beyond these limits. 50 and above 7.0 the discharge can only be considered an approximation.

Estimated monthly discharge of White River at Sharon, Vt., for 1903 and 1904.

[Drainage area, 680 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
July	1,695	263	483	0.710	0.819
August	1,967	298	510	.750	.865
September	513	230	314	.462	.516
October	921	250	471	.693	.799
November 1–21	641	320	416	.612	.478
1904.					
March 27–31	6,270	2,348	3,417	5.02	0.93
April 1–2; 7–30	6,385	1,695	3,105	4.57	4.42
May	4,335	849	1,725	2.54	2.93
June	732	88	395	.581	.6[illegible]
July	335	50	200	.294	.3[illegible]
August [a]	335	140	217	.319	.3[illegible]
September	1,695	88	758	1.11	1.2[illegible]
October	3,475	335	1,540	2.26	2.6[illegible]
November 1–12	2,155	1,160	1,569	2.31	1.0[illegible]

[a] August 9–18 interpolated.

ASHUELOT RIVER AT WINCHESTER, N. H.

This station was established July 10, 1903, by H. K. Barrows. It is located at the steel highway bridge in the village of Winchester. The drainage area at this point is 385 square miles. A standard chain gage is attached to the bottom chord of the upstream truss; length of chain, 25.24 feet. It is referred to bench marks as follows: (1) East end of left abutment; elevation, 20.79 feet. (2) Top of watering trough in the village square; elevation, 25.18 feet. Elevations are above datum of gage. The channel is straight for 300 feet above and 500 feet below the station, and is about 70 feet wide at ordinary stages, broken by one pier. The current is sluggish at low stages of the river, the lowest observed mean velocity having been 0.39 foot per second at gage height 4.02.

The observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Ashuelot River at Winchester, N. H., in 1904.

te.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
.....	N. C. Grover and S. K. Clapp	734	2.35	8.57	1,720
.....	S. K. Clapp.....	490	1.65	5.98	810
.....	.....do	425	1.21	5.32	515
.....	.....do	294	.62	4.00	181
.....	.....do	297	.66	4.05	196
.....	.....do	270	.45	3.62	121
11.....	.....do	297	.44	4.05	131

n daily gage height, in feet, of Ashuelot River at Winchester, N. H., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	7.9	11.8	5.2	5.0	3.4	3.7	5.0	4.2	4.0
.....	9.8	9.8	4.9	5.6	3.8	3.6	4.9	4.2	4.2
.....	10.1	8.4	4.9	5.2	3.8	3.6	4.8	4.2	4.0
.....	9.0	7.4	4.9	4.7	3.6	3.5	4.4	4.2	.....
.....	8.2	7.0	4.6	4.6	3.9	3.4	4.4	4.2	.....
.....	8.0	6.6	4.6	4.4	3.8	3.4	4.4	4.2	.....
.....	8.4	6.2	5.0	4.3	3.5	3.6	4.4	4.2	.....
.....	9.4	5.6	5.3	4.3	3.4	3.6	4.5	4.0	.....
.....	9.9	5.7	5.3	4.4	3.5	3.6	4.5	4.1	.....
.....	11.8	6.2	5.0	4.2	3.5	3.6	4.2	4.0	.....
.....	12.5	6.8	4.8	4.4	4.1	4.1	4.2	3.9	.....
.....	10.7	7.2	4.6	4.2	4.2	3.9	4.2	4.0	.....
.....	9.4	6.7	4.5	3.8	4.2	4.1	4.1	4.1	.....
.....	8.6	6.0	4.5	3.7	3.9	4.1	4.4	4.1	.....
.....	7.8	5.6	4.3	3.6	3.6	5.6	4.4	4.1	.....
.....	7.4	5.7	4.3	3.6	3.8	7.1	4.2	4.3	.....
.....	7.2	6.0	4.2	3.4	3.8	5.4	4.1	4.2	.....
.....	7.7	5.7	4.2	3.4	3.8	4.8	4.0	4.3	.....
.....	7.6	5.9	4.2	3.6	3.7	4.2	4.2	4.2	.....
.....	7.3	6.9	3.7	3.6	3.8	4.4	4.2	4.0	.....
.....	7.0	7.2	4.1	3.5	4.4	4.5	4.1	4.1	.....
.....	7.0	6.5	4.1	3.6	5.0	4.4	5.0	4.2	.....
.....	6.9	6.2	4.2	3.5	4.8	4.5	5.4	4.3	.....
.....	6.5	5.8	4.6	3.4	4.2	4.5	5.4	4.4	.....
.....	6.6	5.5	4.2	3.4	4.0	4.5	4.8	4.5	.....
.....	6.9	5.8	4.1	3.4	3.9	4.1	4.6	4.4	.....
.....	6.9	5.7	4.0	3.7	3.9	4.2	4.6	4.4	.....
.....	8.5	5.4	3.9	3.4	3.9	4.2	4.5	4.2	.....
.....	11.2	5.1	3.9	3.5	3.6	4.2	4.2	4.2	.....
.....	12.5	4.9	4.2	3.5	3.8	4.6	4.2	4.0	.....
.....	.....	5.2	.....	3.4	3.7	.....	4.4	.....	.....

NOTE.—Gage not read during frozen season.

DEERFIELD RIVER AT DEERFIELD, MASS.

Deerfield River is one of the largest tributaries of Connecticut River, having a total drainage area of 667 square miles. It rises in southern Vermont, and joins Connecticut River about 1 mile southeast of Greenfield. It is important as a water-power stream, but is not well supplied with storage reservoirs, consequently subject to considerable fluctuations of flow.

A gaging station was established March 29, 1904, by N. C. Grover, at the suspension highway bridge, about one-fourth mile from West Deerfield railway station, and about 6 or 7 miles above the mouth of the river. The drainage area at this point is 550 square miles. About 2 miles below the station is an old dam, partially destroyed, and back water from Connecticut River reaches the site of this old dam. A standard chain gage is attached to the downstream side of the bridge length of chain, 32.21 feet. The gage is referred to bench marks a follows: (1) Point on bottom chord of bridge, near the zero of gag scale; elevation, 31.49 feet. (2) On top of downstream foundation o bridge pier on the right bank; elevation, 28.92 feet. (3) Copper bol set in ledge on left bank, 20 feet upstream from abutment; elevatior 21.04 feet. All elevations are referred to gage datum.

Discharge measurements are made from the downstream side of th bridge to which the gage is attached, the initial point for sounding being the left end of the top chord of the stiffening truss at the dowı stream side. The channel is straight for about 600 feet above an 1,000 feet below the station. The banks are high, rocky, and clear and not liable to overflow. The bed is clean and permanent, the le half being of gravel and the right half of sand. There is but or channel at all stages. The current is medium, becoming sluggish ı low water, when measurements are made by wading at a point abou one-half mile downstream. The gage is read twice daily by Mr Carrie I. Wellman.

Observations at this station during 1904 have been made under tl direction of H. K. Barrows, district hydrographer.

Discharge measurements of Deerfield River at Deerfield, Mass., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 30	N. C. Grover	2,180	1.10	3.61	2,390
April 11	S. K. Clapp	2,500	2.32	4.68	5,810
April 25	do	2,480	2.02	4.58	5,010
May 18	do	2,270	1.50	3.75	3,420
June 1	do	1,920	.31	2.81	590
June 20 [a]	do	449	1.89	2.70	850
July 28 [a]	do	259	1.98	2.60	513
August 17 [a]	do	168	1.64	2.45	275
September 17	T. W. Norcross	2,015	.63	3.21	1,260
October 27	do	2,010	.49	2.90	981
November 30 [a b]	do	288	1.84	2.60	531

[a] By wading at different sections.
[b] River frozen at gage 0.1 foot thick. Gage height is to bottom of ice.

Mean daily gage height, in feet, of Deerfield River at Deerfield, Mass., for 1904.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.05	4.60	2.80	2.70	2.40	2.30	3.35	2.60	.....
2	.....	5.10	4.40	2.70	2.90	2.40	2.20	2.95	2.65	.....
3	.....	4.15	4.00	2.75	2.65	2.45	2.40	2.75	2.50	.....
4	.....	3.70	3.90	2.85	2.65	2.50	2.40	2.70	2.50	.....
5	.....	3.70	3.75	2.90	2.60	2.40	2.40	2.60	2.50	.....
6	.....	4.00	3.50	2.80	2.55	2.40	2.40	2.60	2.40	.....
7	.....	4.20	3.45	3.05	2.55	2.35	2.30	2.55	2.50	.....
8	.....	4.30	3.35	3.50	2.60	2.30	2.30	2.50	2.40	.....
9	.....	5.45	3.10	6.05	2.55	2.40	2.40	2.50	2.30	.....
10	.....	5.20	3.40	4.05	2.50	2.50	2.50	2.45	2.30	.....
11	.....	4.70	3.50	3.50	2.50	2.80	2.60	2.80	2.30	.....
12	.....	4.20	3.30	3.05	2.50	2.60	2.45	2.80	2.30	.....
13	.....	3.90	3.20	2.90	2.50	2.55	2.35	2.75	2.30	.....
14	.....	3.55	3.15	2.90	2.50	2.50	2.30	2.85	2.40	.....
15	.....	3.40	3.00	2.80	2.45	2.60	5.60	2.80	2.45	.....
16	.....	3.50	3.90	2.80	2.45	2.50	3.65	2.70	2.40	.....
17	.....	3.25	4.00	2.70	2.45	2.40	3.10	2.65	2.30	.....
18	.....	3.40	3.90	2.70	2.55	2.50	2.95	2.60	2.30	.....
19	.....	3.70	4.65	2.70	2.50	2.50	2.85	2.55	2.40	.....
20	.....	3.30	4.50	2.65	2.55	2.65	2.65	2.50	2.45	.....
21	.....	3.25	3.70	2.60	2.40	3.95	2.50	4.20	2.60	.....
22	.....	3.25	3.50	2.55	2.40	3.00	2.45	4.80	2.80	.....
23	.....	3.50	3.30	2.55	2.40	2.65	2.45	3.65	2.70	.....
24	.....	3.65	3.20	2.60	2.40	2.55	2.55	3.00	2.60	.....
25	.....	4.40	3.15	2.60	2.45	2.50	2.60	2.80	2.50	.....
26	.....	4.40	3.20	2.80	2.55	2.50	2.60	2.80	2.40	.....
27	.....	4.50	3.20	2.55	2.60	2.45	2.60	2.80	2.30	.....
28	.....	5.85	3.00	2.50	2.60	2.40	2.60	2.70	2.35	.....
29	3.85	5.95	2.90	2.35	2.50	2.40	2.80	2.70	2.40	.....
30	3.65	4.90	2.70	2.60	2.40	2.30	4.30	2.60	[a] 2.30	.....
31	3.65	.....	2.85	.....	2.40	2.30	.....	2.50	.....	.....

[a] River entirely frozen on November 30.

WARE RIVER NEAR WARE, MASS.

Ware River is formed in the town of Barre by the junction of several small streams. The surrounding country is hilly and largely cleared. The total drainage area is about 223 square miles, and is a tributary to Chicopee River, which drains a large section of central Massachusetts, and is the largest tributary of the Connecticut in respect to drainage area, its basin containing 730 square miles. It is formed at Three Rivers by the union in that vicinity of the Ware, Swift, and Quabog rivers; thence runs westerly about 15 miles, joining the Connecticut at Chicopee. Chicopee River and its tributaries are quite important water-power streams, and expensive developments have been made upon them.

A gaging station was established on September 15, 1904, by H. K. Barrows, at the steel highway bridge—span of about 85 feet—about 2 miles above the village of Ware. The drainage area at this point is 162 square miles. A standard chain gage is fastened to the floor timbers of the bridge on the upstream side toward the right bank; length of chain, 14.10 feet. It is referred to bench marks as follows: (1) On post of bridge railing at east end of gage; elevation, 17.01 feet. (2) On west abutment on downstream side about 18 inches from the corner near the truss; elevation, 11.48 feet. (3) Southeast corner of abutment of railroad culvert, about 250 feet north of the Boston and Maine Railroad crossing, west of gage; elevation, 18.63 feet. All bench marks are referred to gage datum.

Discharge measurements are made usually from the upstream side of the bridge to which the gage is attached. The initial point for soundings is left abutment at the top; the channel is curved for some little distance above the bridge and straight below the bridge. The bed of the stream is rocky with some gravel. The banks are medium in height and overflow at very high water, when there will be two or more channels. The current is swift at high stages and well sustained at low stages. The gage is read twice daily by M. N. Richards, a farmer. The expense of a gage reader at this point is borne equally by the Otis Company and the George H. Gilbert Manufacturing Company, both of Ware.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Ware River near Ware, Mass., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
September 15	H. K. Barrows	250	3.45	4.44	863
September 20	T. W. Norcross	106	1.59	2.59	169
October 5	do	95	1.75	2.63	166
October 19	do	106	1.93	2.70	205
October 29	do	113	1.71	2.80	193
November 14	do	89	1.49	2.46	133

Mean daily gage height, in feet, of Ware River near Ware, Mass., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		2.75	2.40	2.60	17	3.50	2.40	2.70	
2		2.50	2.75	2.60	18	2.75	2.35	2.50	
3		2.90	2.60	2.60	19	2.80	2.70	2.30	
4		2.85	2.65	2.10	20	2.55	2.50	2.00	
5		2.70	2.60	2.75	21	2.60	2.80	2.90	
6		2.70	2.15	2.70	22	2.85	2.90	2.80	
7		2.60	2.60	2.70	23	2.70	2.70	2.75	
8		2.30	2.70	2.50	24	2.60	3.00	2.50	
9		2.15	2.75	2.45	25	2.30	2.75	2.70	
10		2.55	2.75	(a)	26	2.55	2.90	2.40	
11		2.80	2.65		27	2.90	2.80	2.50	
12		2.60	2.10		28	2.50	2.70	3.20	
13		2.65	2.15		29	2.40	2.50	2.90	
14		2.80	2.65		30	2.80	2.40	2.70	
15	4.35	2.60	2.60		31		2.45		
16	4.40	2.40	2.70						

a River frozen over December 10-31.

WARE RIVER AT GILBERTVILLE, MASS.

Records of flow of Ware River have been kept at the lower mill through the courtesy and assistance of the George H. Gilbert Manufacturing Company, at Gilbertville, since September 22, 1904. The drainage area at this point is 160 square miles. The lower dam is 101.5 feet long with a fairly even crest. The greater part of the time, however, all of the water at this point is used through the wheels, and the record is kept largely by means of the record of wheel openings. These wheels have been rated at Holyoke, and, in addition to this, current-meter gagings are made from time to time as a check on the flow. The average head on wheels is about 19.5 feet. Records of flow at this point during 1904 are withheld, awaiting confirmation of data.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

QUABOG RIVER AT WEST WARREN, MASS.

Quabog River is some 25 miles in length with a drainage area of 213 square miles. It is an especially valuable stream as regards water power, on account of its well sustained flow and absence of effect from freshets. There is still a large amount of power below West Warren which is not developed.

A station for securing a record of flow of Quabog River has been maintained by the United States Geological Survey at West Warren at the dam of J. T. F. MacDonnell, of Holyoke, since October 22, 1904. The drainage area at this point is 144 square miles. The dam is timber crib, 102.7 feet long between vertical abutments, and affords a fall of about 13 feet. This dam is leased by the Composite Leather Company, but no power is used at the present time; so that the whole flow is over the dam.

A plain staff gage is placed near the canal head-gates at the dam, on the left side. Elevation 50 of this gage corresponds to the level of the crest of the dam. This gage is read once a day by Amory Cressman. Records of flow at this point during 1904 have been withheld, awaiting confirmation of data.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

SWIFT RIVER AT WEST WARE, MASS.

Swift River is some 30 miles long and drains a total area of 218 square miles. It drains a hilly country very similar to that of Ware River, but perhaps more thickly wooded. There is enough storage on this river to make the flow well sustained during the dry period.

Records of flow of Swift River have been kept at the mill of the West Ware Paper Company, through the courtesy of Mr. Dwight Holland, manager, since October 21, 1904. The drainage area at this point is 188 square miles. The dam at West Ware is timber crib; has a total length of 150 feet between vertical abutments, with a fairly good crest. A considerable portion of the time all of the water is used at this point through the wheels, and record is kept largely by means of them. One of the wheels has been rated at Holyoke, and additional current-meter measurements are made to serve as a check on the computations. The average head on the wheels is about 11 feet. Records of flow at this point during 1904 are withheld awaiting confirmation of data.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

WESTFIELD RIVER AT RUSSELL, MASS.

The main branch of Westfield River rises in the northeasterly part of Berkshire County, entering Connecticut River at Springfield, with a total length of about 55 miles. Its principal tributaries are the West Branch and Middle Branch, respectively; length of the West Branch from the mouth being 22 miles and that of the Middle Branch 24 miles. The country in this drainage basin is very hilly and even mountainous at its headwaters. Slopes are steep and rocky. There is little storage, consequently rapid fluctuations in the flow.

This station was established April 1, 1904, by N. C. Grover. It is located at the steel highway bridge of two spans, which are about 250 feet long, near the railway station at Russell, Mass. The drainage area at this point is 331 square miles. A standard chain gage is attached to the upstream side of the bridge near the center of the left span; length of chain, 23.98 feet. The gage is referred to bench marks as follows: (1) Top of plank floor near the zero of gage scale; elevation, 22.89 feet. (2) Upstream inner corner of left abutment near post; elevation, 22.31 feet. (3) Upstream inner corner of right abutment near post; elevation, 24.76 feet. All elevations are referred to gage datum.

Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is the face of left abutment, downstream side at the top. The channel is straight for 1,000 feet above and below the station. The bed of the stream is of gravel and small bowlders, very rough but permanent. Both banks are high, rocky, and clean, and not subject to overflow. There are two channels at all stages; current is swift at all times. The gage is read twice daily by B. A. Silliman, station agent at Russell.

Observations at this station during 1904 have been made under the direction of H. K. Barrows, district hydrographer.

Discharge measurements of Westfield River at Russell, Mass., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 2	N. C. Grover and S. K. Clapp.	700	7.13	3.37	4,990
April 27	S. K. Clapp	323	4.13	1.72	1,330
June 3	do	210	2.53	1.10	531
June 22	do	165	2.14	.98	353
July 29[a]	do	130	2.88	.85	374
July 30	do	132	1.59	.90	210
August 18	do	134	1.67	.90	224
September 16	H. K. Barrows and T. W. Norcross.	348	2.96	1.95	1,030
October 4	T. W. Norcross	167	1.49	.99	249
October 26	do	226	2.39	1.30	540
November 29[b]	do	161	1.21	.99	196

[a] Wading 1¼ miles below bridge. [b] Poor conditions due to anchor ice.

Mean daily gage height, in feet, of Westfield River at Russell, Mass., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	2.15	1.10	2.20	0.80	0.90	1.30	1.10	1.2[illegible]
2	3.65	1.90	1.10	1.75	.90	.90	1.10	1.05	1.1[illegible]
3	2.75	1.80	1.10	1.40	.85	.85	1.00	1.05	1.[illegible]
4	2.20	1.70	1.05	1.20	.80	.80	.95	1.10	1.[illegible]
5	2.20	1.60	1.20	1.10	.80	.80	.90	1.10	1.[illegible]
6	2.45	1.55	1.60	1.40	.80	.80	.90	1.10	1.[illegible]
7	2.65	1.50	3.60	1.15	.70	.70	.90	1.05	.....
8	2.70	1.40	2.15	1.00	.70	.80	.85	1.00	.....
9	3.20	1.50	4.15	.95	.80	.80	.80	1.00	.....
10	3.30	1.70	2.45	.90	.80	.80	.85	1.00	.....
11	2.65	1.00	1.90	.95	2.55	.85	.90	1.00	.....
12	2.40	1.45	1.65	.95	1.40	.80	1.00	1.00	.....
13	2.20	1.30	1.45	1.05	1.10	.80	1.15	.95	.....
14	1.95	1.25	1.35	1.05	1.00	.80	1.20	1.00	.....
15	1.80	1.20	1.30	.95	1.10	4.20	1.10	1.05	.....
16	1.80	1.90	1.20	.90	1.00	2.00	1.00	1.10	.....
17	1.75	1.65	1.15	.90	.90	1.40	.95	1.05	.....
18	1.90	1.50	1.10	1.20	.90	1.20	.90	.95	.....
19	2.00	1.85	1.05	1.05	.85	1.10	.90	1.00	.....
20	1.80	2.30	1.05	.90	1.20	1.05	.90	1.10	.....
21	1.70	1.75	1.00	.90	2.00	1.00	3.40	1.25	.....
22	1.65	1.45	1.00	.70	1.30	1.00	2.45	1.30	.....
23	1.65	1.35	1.00	.80	1.10	.95	1.70	1.20	.....
24	1.65	1.30	1.00	.90	1.00	1.00	1.40	1.20	.....
25	1.80	1.20	.95	1.00	.95	1.00	1.30	1.15	.....
26	1.80	1.70	1.00	1.00	.90	1.05	1.20	1.05	.....
27	1.85	1.50	.95	1.00	.90	1.00	1.20	.95	.....
28	3.30	1.30	.95	1.00	.80	1.00	1.20	1.00	.....
29	3.50	1.20	1.00	.95	.80	1.00	1.15	1.00	.....
30	2.55	1.15	1.35	.90	.80	1.55	1.10	1.10	.....
31	.....	1.15	.....	.80	.80	.....	1.10	.....	.....

HOUSATONIC DRAINAGE BASIN.

Housatonic River has its source in Berkshire County, Mass. It flows southerly across Massachusetts and the western end of Connecticut, entering Long Island Sound. Its course is nearly parallel to the eastern boundary of New York State, and it receives the drainage from Tenmile River in New York.

Tenmile River drains an area of diversified topography, including broad flats and marshes in the basin of Swamp River and extensive areas under cultivation and sparsely timbered hills in the region of the Chestnut Range. The drainage area lies chiefly in New York State, the stream crossing the line into Connecticut one-half mile above the junction with the Housatonic. Stations have been maintained in this basin on Housatonic River at Gaylordsville, Conn., and on Tenmile River near Dover Plains, N. Y.

HOUSATONIC RIVER AT GAYLORDSVILLE, CONN.

This station was established October 24, 1900, by E. G. Paul. The gage is located at the covered wooden highway bridge at Gaylordsville, Conn., 2 miles below the mouth of Tenmile River and 1¼ miles above the cable from which discharge measurements are made. The chain gage is fastened to the woodwork of the inside of the bridge. The length of the chain from the end of the weight to the marker is 30.45 feet. The gage is read twice each day by G. H. Munroe. On account of the poor cross section of the channel at the bridge, discharge measurements are made by means of a three-fourths-inch cable and car 1¼ miles below. The cable has a span of 200 feet. It is supported on the right bank by timbers 25 feet high, and is anchored to a large rock buried in the ground. On the left bank the cable is supported by a large sycamore tree and fastened to the base of a large oak. The initial point for soundings is the zero of the tagged wire at the sycamore tree which supports the cable on the left bank. The channel is straight for about 500 feet above and below the station. The current at the cable never becomes too sluggish to be accurately measured. At high water the current is swift and rough. Both banks are subject to overflow only at extreme freshets. Both banks have a sparse growth of trees and brush. The bed of the stream is composed of gravel and cobblestones, free from vegetation, and not subject to change. No bench mark has been established. The center of the gage pulley is 29.35 feet above gage datum.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Housatonic River at Gaylordsville, Conn., in 1900–19

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Disch
1900.		*Square feet.*	*Ft. per sec.*	*Feet.*	*Secon*
August 9 [a]	E. G. Paul	272	1.66	3.30	
August 10 [a]	do	232	1.82	3.25	
October 20	do	236	1.28	3.10	
October 24	do	251	1.47	3.00	
1901.					
March 30	A. K. Chittenden	1,014	4.64	6.20	
April 27	do	1,311	5.65	7.20	
August 3	A. E. Place	322	1.78	3.50	
September 13	do	462	1.98	4.00	
September 28	W. W. Schlecht	384	1.83	3.77	
October 29	do	444	2.14	4.05	
November 13	do	648	2.88	4.82	
November 23	do	455	2.12	4.11	
December 28	do	758	3.32	5.16	
1902.					
January 11	W. W. Schlecht	677	3.23	5.00	
February 14 [b]	do	446	2.49	8.30	
March 4	do	2,090	6.51	9.90	1
March 18	do	1,469	5.64	7.63	
May 3	do	1,010	4.41	6.10	
June 23	do	498	2.36	4.46	
July 11	H. K. Barrows	496	2.34	4.30	
July 22	do	1,194	4.28	6.68	
August 5	do	476	2.06	4.28	
August 20	do	423	1.97	3.95	
September 8	do	352	1.54	3.45	
September 19	do	367	1.74	3.75	
October 3	P. M. Churchill	693	3.08	5.35	
November 15	F. H. Tillinghast	570	2.38	4.50	
November 29	do	560	2.29	4.40	
December 20	do	1,140	4.79	6.65	
1903.					
January 23	F. H. Tillinghast	812	3.23	5.50	
March 31	do	1,092	4.37	6.52	
June 6	do	359	1.48	3.60	
July 24	do	693	2.97	5.20	
September 15	do	785	1.86	3.90	
1904.					
July 16	C. C. Covert	363	1.64	3.80	

[a] Measurement at different sections.

[b] Backwater from ice.

laily gage height, in feet, of Housatonic River at Gaylordsville, Conn., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	4.85	6.85	6.25	6.15	6.00	4.85	5.40	3.80	3.55	4.45	4.25	4.25
.....	4.75	6.15	6.05	6.75	5.90	4.75	5.85	3.80	3.60	4.50	4.40	4.25
.....	4.05	6.60	6.30	6.60	5.60	4.65	5.20	3.85	3.55	4.30	4.45	4.15
.....	4.10	6.65	7.65	6.70	5.55	4.60	4.65	4.00	3.60	4.00	4.50	4.05
.....	4.10	6.40	6.10	6.45	5.25	4.55	4.35	4.00	3.60	4.20	4.45	4.00
.....	4.05	6.45	5.45	6.10	5.20	4.45	4.40	3.85	3.15	4.25	4.45	3.85
.....	[a] 4.10	6.30	[b] 6.00	6.10	5.05	4.20	4.55	3.85	3.40	4.20	4.30	4.00
.....	3.95	8.45	9.15	6.00	5.10	5.30	4.60	3.70	3.35	4.10	4.20	4.05
.....	4.10	8.00	7.35	6.15	4.65	6.55	4.50	3.40	3.45	4.15	4.25	3.95
.....	4.55	8.40	6.65	6.50	4.50	7.35	4.45	3.85	3.70	4.05	4.20	3.90
.....	4.65	8.50	6.75	6.45	4.55	7.05	4.30	3.90	3.70	3.75	4.25	3.85
.....	4.55	6.90	6.00	6.40	4.60	6.60	3.85	5.30	3.60	4.15	4.15	4.05
.....	5.50	6.30	5.60	6.30	4.50	6.15	4.30	4.85	3.35	4.25	4.20	4.00
.....	5.85	7.10	5.45	6.15	4.70	5.55	4.25	3.90	3.35	4.25	4.45	3.90
.....	6.15	6.90	5.30	5.85	4.70	5.10	4.15	3.90	7.35	4.00	4.45	3.95
.....	6.20	6.10	5.05	5.90	5.25	5.05	4.15	4.20	6.60	4.15	4.55	4.15
.....	[c] 6.35	6.10	5.00	5.55	5.00	4.85	4.00	4.10	6.00	4.20	4.45	4.20
.....	5.95	6.25	4.95	5.60	5.25	4.75	4.00	4.00	5.00	4.05	4.30	[d] 4.15
.....	5.85	6.10	5.05	5.50	5.25	4.70	4.05	3.80	4.65	4.05	4.30	4.10
.....	6.25	[e] 5.90	5.30	5.45	5.15	4.60	3.55	4.05	4.55	4.20	4.25	4.05
.....	6.40	6.50	5.30	5.50	5.15	4.25	3.90	4.40	4.55	5.10	4.30	4.20
.....	6.60	7.10	5.65	5.40	5.15	4.65	4.00	4.50	4.15	6.10	4.35	4.25
.....	7.80	8.50	5.65	5.30	4.95	4.50	3.70	4.25	4.00	5.85	4.60	4.05
.....	9.25	8.00	6.35	5.15	4.70	4.30	3.50	4.20	3.95	5.05	4.55	4.20
.....	9.25	[f] 8.00	6.50	5.05	4.90	4.00	3.75	4.10	4.45	5.40	4.30	4.30
.....	[g] 8.55	7.00	6.80	5.10	4.75	4.25	3.70	3.80	4.30	5.25	4.50	4.30
.....	9.15	4.00	7.55	5.20	5.75	4.15	4.55	3.80	4.25	4.85	4.20	4.25
.....	8.00	[e] 5.00	7.50	6.15	5.30	3.75	4.10	3.80	4.40	4.80	4.05	4.70
.....	8.05	4.20	7.05	6.40	5.10	4.15	3.95	3.35	4.30	4.70	4.10	4.50
.....	7.85	.....	6.60	6.60	4.75	4.50	3.80	3.45	4.65	4.60	4.25	4.30
.....	7.55	.....	6.10	.....	4.90	.....	3.80	3.50	.....	4.50	.....	[d] 4.20

. foot thick.
went out.
1½ feet thick.
ember 18–31 river partly frozen. Ice 10–12 inches at gage.

[e] Ice 2½ feet thick.
[f] Ice 3 feet thick.
[g] Ice 2 feet thick.

Rating table for Housatonic River at Gaylordsville, Conn., from October 23, 1900, December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Dischar
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-f*
2.5	120	4.6	1,506	6.7	5,448	8.8	10,98
2.6	157	4.7	1,642	6.8	5,692	8.9	11,25
2.7	193	4.8	1,778	6.9	5,936	9.0	11,5
2.8	230	4.9	1,914	7.0	6,180	9.1	11,8
2.9	266	5.0	2,050	7.1	6,440	9.2	12,0
3.0	303	5.1	2,216	7.2	6,700	9.3	12,3
3.1	352	5.2	2,382	7.3	6,960	9.4	12,6
3.2	402	5.3	2,548	7.4	7,220	9.5	12,9
3.3	451	5.4	2,714	7.5	7,480	9.6	13,1
3.4	501	5.5	2,880	7.6	7,744	9.7	13,4
3.5	550	5.6	3,076	7.7	8,008	9.8	13,7
3.6	618	5.7	3,272	7.8	8,272	9.9	14,0
3.7	686	5.8	3,468	7.9	8,536	10.0	14,3
3.8	754	5.9	3,664	8.0	8,800	10.1	14,6
3.9	822	6.0	3,860	8.1	9,070	10.2	14,9
4.0	890	6.1	4,080	8.2	9,340	10.3	15,2
4.1	986	6.2	4,300	8.3	9,610	10.4	15,5
4.2	1,082	6.3	4,520	8.4	9,880	10.5	15,8
4.3	1,178	6.4	4,740	8.5	10,150		
4.4	1,274	6.5	4,960	8.6	10,430		
4.5	1,370	6.6	5,204	8.7	10,700		

The above table is applicable only for open-channel conditions. It is based discharge measurement made during 1900–1904. It is fairly well defined bet gage heights 3 feet and 5 feet. Above 5 feet the measurements are scattered.

Mean daily discharge, in feet, of Housatonic River at Gaylordsville, Conn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	4,190	3,860	1,850	2,710	754	584	1,320	1,130	1,130
2	.....	.....	.....	5,570	3,660	1,710	3,570	754	618	1,370	1,270	1,130
3	.....	.....	.....	5,200	3,080	1,570	2,380	788	584	1,180	1,320	1,030
4	.....	.....	.....	5,450	2,980	1,510	1,570	890	618	890	1,370	938
5	.....	.....	.....	4,850	2,460	1,440	1,230	890	618	1,080	1,320	890
6	.....	.....	.....	4,080	2,380	1,320	1,270	788	377	1,130	1,320	788
7	.....	.....	.....	4,080	2,130	1,080	1,440	788	501	1,080	1,180	890
8	.....	.....	11,940	3,860	2,220	2,550	1,510	686	476	986	1,080	938
9	.....	.....	7,090	4,190	1,570	5,080	1,370	501	525	1,030	1,130	856
10	.....	.....	5,330	4,960	1,370	7,090	1,320	788	686	938	1,080	822
11	.....	.....	5,570	4,850	1,440	6,310	1,180	822	686	720	1,130	788
12	.....	.....	3,860	4,740	1,510	5,200	790	2,550	618	1,030	1,030	938
13	.....	.....	3,080	4,520	1,370	4,190	1,180	1,850	476	1,130	1,080	890
14	.....	.....	2,800	4,190	1,640	2,980	1,130	822	476	1,130	1,320	822
15	.....	.....	2,550	3,570	1,640	2,220	1,030	822	7,090	890	1,320	856
16	.....	.....	2,130	3,660	2,460	2,130	1,030	1,080	5,200	1,030	1,440	.....
17	.....	.....	2,050	2,980	2,050	1,850	890	986	3,860	1,080	1,320	.....
18	.....	.....	1,980	3,080	2,460	1,710	890	890	2,050	938	1,180	.....
19	.....	.....	2,130	2,880	2,460	1,640	938	754	1,570	938	1,180	.....
20	.....	.....	2,550	2,800	2,300	1,510	584	938	1,440	1,080	1,130	.....
21	.....	.....	2,550	2,880	2,300	1,130	822	1,270	1,440	2,220	1,180	.....
22	.....	.....	3,170	2,710	2,300	1,570	890	1,370	1,030	4,080	1,230	.....
23	.....	.....	3,170	2,550	1,980	1,370	686	1,130	890	3,570	1,510	.....
24	.....	.....	4,630	2,300	1,640	1,180	550	1,080	856	2,130	1,440	.....
25	.....	.....	4,960	2,130	1,910	890	720	986	1,320	2,710	1,180	.....
26	.....	.....	5,690	2,220	1,710	1,130	686	754	1,180	2,460	1,370	.....
27	.....	.....	7,610	2,380	3,370	1,030	1,440	754	1,130	1,850	1,080	.....
28	.....	.....	7,480	4,190	2,550	720	986	754	1,270	1,780	938	.....
29	.....	.....	6,310	4,740	2,220	1,030	856	476	1,180	1,640	986	.....
30	.....	.....	5,200	5,200	1,710	1,370	754	525	1,570	1,510	1,130	.....
31	.....	.....	4,080	.....	1,910	.....	754	550	.....	1,370	.....	.....

Estimated monthly discharge of Housatonic River at Gaylordsville, Conn., for 190

[Drainage area, 1,020 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dept inch
March 8–31	11,940	1,980	4,496	4.41	3.
April	5,570	2,130	3,833	3.76	4.
May	3,860	1,370	2,214	2.17	2.
June	7,090	720	2,212	2.17	2.
July	3,570	550	1,199	1.18	1.
August	2,550	476	929	0.911	1.
September	7,090	377	1,364	1.34	1.
October	4,080	720	1,493	1.46	1.
November	1,510	938	1,212	1.19	1.
December 1–15	1,130	788	914	.896	.

INDEX.

Ammonoosuc River at— Page
Bretton Woods, N. H.:
description 128-129
discharge..... 129
discharge, monthly 131
gage heights..... 130
rating table 130
Androscoggin River at and near—
Dixfield, Me.:
description 78-79
discharge..... 79
gage heights..... 79
Errol dam, New Hampshire:
description 75-76
Gorham, N. H.:
description 76
Rumford Falls, Me.:
description 78
Shelburne, N. H.:
description 76
discharge..... 77
gage heights..... 77
Androscoggin River drainage basin:
description 74-75
Aroostook River at—
Fort Fairfield, Me.:
description 23-24
discharge..... 24
discharge, monthly 26
gage heights..... 24-25
rating table..... 25
Ashuelot River at—
Winchester, N. H.:
description 138
discharge..... 139
gage heights..... 139
Baring, Me.
St. Croix River near:
description 27-28
discharge..... 28
discharge, monthly 30
gage heights..... 29
rating table..... 30
Blackstone River at—
Woonsocket, R. I.:
description 109-110
discharge..... 110
gage heights..... 110-111
Blackstone River drainage basin:
description 109
Bretton Woods, N. H.
Ammonoosuc River at:
description 128-129
discharge..... 129
Bretton Woods, N. H.—Continued. Page.
Ammonoosuc River at—Continued.
discharge, monthly 131
gage heights..... 130
rating table..... 130
Carrabassett River at—
North Anson, Me.:
description 67-68
discharge..... 68
discharge, monthly 70
gage heights..... 69
rating table 70
Center Conway, N. H.
Saco River near:
description 82
discharge..... 82
discharge, monthly 84
gage heights..... 83
rating table 84
Clinton, Mass.
Nashua River (South Branch) at:
description 108
rainfall..... 108
yield 108-109
Cobbosseecontee River at—
Gardiner, Me.:
description 73-74
discharge 74
Cochituate, Mass.
Lake Cochituate at:
description 105
rainfall..... 107
yield 107
Cold Stream at—
Enfield, Me.:
description 50-51
discharge 51
gage heights..... 51
Connecticut River at and near—
Hartford, Conn.:
description 121-122
gage heights..... 122
Orford, N. H.:
description 115
discharge..... 116
discharge, monthly..... 119
gage heights..... 117
rating table 118-119
Sunderland, Mass.:
description 120
discharge..... 120
gage heights..... 121
Connecticut River drainage basin:
description 113-115

Page.

Contoocook River at—
West Hopkinton, N. H.:
description 101-102
discharge 102
discharge, monthly 104
gage heights 103
rating table 104

Dead River near—
The Forks, Me.:
description 66
discharge 66
gage heights 67

Dedham, Me.:
Phillips Lake in:
description 52-53
gage heights 54

Deerfield, Mass.
Deerfield River at:
description 140
discharge 141
gage heights 141

Deerfield River at—
Deerfield, Mass.:
description 140
discharge 141
gage heights 141

Dixfield, Me.
Androscoggin River near:
description 78-79
discharge 79
gage heights 79

East Holden, Me.
Phillips Lake near:
description 52-53
gage heights 54
Phillips Lake (north outlet) at:
description 52-53
discharge 53

East Pembroke, N. H.
Suncook River at:
description 105

Enfield, Me.
Cold Stream at:
description 50-51
discharge 51
gage heights 51

Errol dam, New Hampshire.
Androscoggin River at:
description 75-76

Fish River at—
Wallagrass, Me.:
description 21-22
discharge 22
gage heights 23

Fort Fairfield, Me.
Aroostook River at:
description 23-24
discharge 24
discharge, monthly 26
gage heights 24-25
rating table 25

Foxcroft, Me.
Piscataquis River near:
description 47-48
discharge 48
discharge, monthly 50
gage heights 48-49
rating table 49

Page.

Framingham, Mass.
Sudbury River at:
description 105
run-off 106

Franklin Junction, N. H.
Merrimac River at:
description 86
discharge 87
discharge, monthly 88
gage heights 87
rating table 88

Gardiner, Me.
Cobbosseecontee River at:
description 73-74
discharge 74

Garvins Falls, New Hampshire.
Merrimac River at:
description 89

Gaylordsville, Conn.
Housatonic River at:
description 147
discharge 148
discharge, mean daily 151
discharge, monthly 152
gage heights 149
rating table 150

Gilbertville, Mass.
Ware River at:
description 143

Gorham, N. H.
Androscoggin River at:
description ..... 7[illegible]

Greenlake, Me.
Phillips Lake (southeast outlet) near:
description ..... 52-[illegible]
discharge ..... [illegible]

Grindstone, Me.
Penobscot River (East Branch) at:
description ..... 40-[illegible]
discharge ..... [illegible]
discharge, monthly ..... [illegible]
gage heights ..... [illegible]
rating table ..... [illegible]

Hartford, Conn.
Connecticut River at:
description ..... 121-12[illegible]
gage heights ..... 12[illegible]

Holden, Me.
Phillips Lake in:
description 52-53

Housatonic River at—
Gaylordsville, Conn.:
description 147
discharge 148
discharge, mean daily 151
discharge, monthly 152
gage heights 149
rating table 150

Housatonic River drainage basin:
description 147

Israel River (above South Branch) near—
Jefferson Highlands, N. H.:
description 123
discharge 123
discharge, monthly 125
gage heights 124
rating table 124

	Page.
low South Branch) near—	
ighlands, N. H.:	
ion	125–126
ge	126
ge, monthly	128
ights	127
able	127
ands, N. H.	
r (above South Branch)	
ion	123
ge	123
ge, monthly	125
ghts	124
able	124
r (below South Branch)	
ion	125–126
ge	126
ge, monthly	128
ights	127
able	127
r at—	
n, Me.:	
ion	59–60
ge	60
ge, monthly	62
ights	61
able	62
Me.:	
ion	56–57
ge	57
ge, monthly	59
ights	58
able	58
Me.:	
ion	62–63
ge	63
r drainage basin:	
	55–56
e at—	
Mass.:	
ion	105
	107
	107
s.	
tiver at:	
ion	89–90
	90–93
ar—	
tain, N. H.:	
tion	134–135
ge	135
ights	135
near—	
le, Me.	
tion	31
ge	32
ge, monthly	33
ights	32
able	33
drainage basin:	
	31
r near:	
tion	71–72
Mattawamkeag, Me.	
Mattawamkeag River at:	
description	44
discharge	45
discharge, monthly	47
gage heights	45–46
rating table	46
Mattawamkeag River at—	
Mattawamkeag, Me.:	
description	44
discharge	45
discharge, monthly	47
gage heights	45–46
rating table	46
Merrimac River at—	
Franklin Junction, N. H.:	
description	86
discharge	87
discharge, monthly	88
gage heights	87
rating table	88
Garvins Falls, New Hampshire:	
description	89
Lawrence, Mass.:	
description	89–90
flow	90–93
Merrimac River drainage basin:	
description	85–86
Messalonskee River at—	
Waterville, Me.:	
description	72
discharge	73
Millinocket, Me.	
Penobscot River at—	
description	36
discharge	37
Moose River near—	
Rockwood, Me.:	
description	64
gage heights	64
Nashua River (South Branch) at—	
Clinton, Mass.:	
description	108
rainfall	108
yield	108–109
North Anson, Me.	
Carrabassett River at:	
description	67–68
discharge	68
discharge, monthly	70
gage heights	69
rating table	70
Kennebec River at:	
description	59–60
discharge	60
discharge, monthly	62
gage heights	61
rating table	62
Orford, N. H.	
Connecticut River near:	
description	115
discharge	116
discharge, monthly	119
gage heights	117
rating table	118–119

Estimated monthly discharge of Housatonic River at Gaylordsville, Conn., for 1904.

[Drainage area, 1,020 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dep inc
March 8–31	11,940	1,980	4,496	4.41	3
April	5,570	2,130	3,833	3.76	4
May	3,860	1,370	2,214	2.17	2
June	7,090	720	2,212	2.17	2
July	3,570	550	1,199	1.18	1
August	2,550	476	929	0.911	1
September	7,090	377	1,364	1.34	
October	4,080	720	1,493	1.46	
November	1,510	938	1,212	1.19	
December 1–15	1,130	788	914	.896	

INDEX.

	Page
Ammonoosuc River at—	
Bretton Woods, N. H.:	
description	128–129
discharge	129
discharge, monthly	131
gage heights	130
rating table	130
Androscoggin River at and near—	
Dixfield, Me.:	
description	78–79
discharge	79
gage heights	79
Errol dam, New Hampshire:	
description	75–76
Gorham, N. H.:	
description	76
Rumford Falls, Me.:	
description	78
Shelburne, N. H.:	
description	76
discharge	77
gage heights	77
Androscoggin River drainage basin:	
description	74–75
Aroostook River at—	
Fort Fairfield, Me.:	
description	23–24
discharge	24
discharge, monthly	26
gage heights	24–25
rating table	25
Ashuelot River at—	
Winchester, N. H.:	
description	138
discharge	139
gage heights	139
Baring, Me.	
St. Croix River near:	
description	27–28
discharge	28
discharge, monthly	30
gage heights	29
rating table	30
Blackstone River at—	
Woonsocket, R. I.:	
description	109–110
discharge	110
gage heights	110–111
Blackstone River drainage basin:	
description	109
Bretton Woods, N. H.	
Ammonoosuc River at:	
description	128–129
discharge	129
Bretton Woods, N. H.—Continued.	
Ammonoosuc River at—Continued.	
discharge, monthly	131
gage heights	130
rating table	130
Carrabassett River at—	
North Anson, Me.:	
description	67–68
discharge	68
discharge, monthly	70
gage heights	69
rating table	70
Center Conway, N. H.	
Saco River near:	
description	82
discharge	82
discharge, monthly	84
gage heights	83
rating table	84
Clinton, Mass.	
Nashua River (South Branch) at:	
description	108
rainfall	108
yield	108–109
Cobbosseecontee River at—	
Gardiner, Me.:	
description	73–74
discharge	74
Cochituate, Mass.	
Lake Cochituate at:	
description	105
rainfall	107
yield	107
Cold Stream at—	
Enfield, Me.:	
description	50–51
discharge	51
gage heights	51
Connecticut River at and near—	
Hartford, Conn.:	
description	121–122
gage heights	122
Orford, N. H.:	
description	115
discharge	116
discharge, monthly	119
gage heights	117
rating table	118–119
Sunderland, Mass.:	
description	120
discharge	120
gage heights	121
Connecticut River drainage basin:	
description	113–115

Page.

Contoocook River at—
West Hopkinton, N. H.:
description 101-102
discharge 102
discharge, monthly 104
gage heights 103
rating table 104

Dead River near—
The Forks, Me.:
description 66
discharge 66
gage heights 67

Dedham, Me.:
Phillips Lake in:
description 52-53
gage heights 54

Deerfield, Mass.
Deerfield River at:
description 140
discharge 141
gage heights 141

Deerfield River at—
Deerfield, Mass.:
description 140
discharge 141
gage heights 141

Dixfield, Me.
Androscoggin River near:
description 78-79
discharge 79
gage heights 79

East Holden, Me.
Phillips Lake near:
description 52-53
gage heights 54
Phillips Lake (north outlet) at:
description 52-53
discharge 53

East Pembroke, N. H.
Suncook River at:
description 105

Enfield, Me.
Cold Stream at:
description 50-51
discharge 51
gage heights 51

Errol dam, New Hampshire.
Androscoggin River at:
description 75-76

Fish River at—
Wallagrass, Me.:
description 21-22
discharge 22
gage heights 23

Fort Fairfield, Me.
Aroostook River at:
description 23-24
discharge 24
discharge, monthly 26
gage heights 24-25
rating table 25

Foxcroft, Me.
Piscataquis River near:
description 47-48
discharge 48
discharge, monthly 50
gage heights 48-49
rating table 49

Page.

Framingham, Mass.
Sudbury River at:
description 10
run-off 10

Franklin Junction, N. H.
Merrimac River at:
description 8
discharge 8
discharge, monthly 8
gage heights 8
rating table 8

Gardiner, Me.
Cobbosseecontee River at:
description 73-
discharge .....

Garvins Falls, New Hampshire.
Merrimac River at:
description .....

Gaylordsville, Conn.
Housatonic River at:
description .....
discharge .....
discharge, mean daily .....
discharge, monthly .....
gage heights .....
rating table .....

Gilbertville, Mass.
Ware River at:
description .....

Gorham, N. H.
Androscoggin River at:
description .....

Greenlake, Me.
Phillips Lake (southeast outlet) near:
description 5
discharge .....

Grindstone, Me.
Penobscot River (East Branch) at:
description 4
discharge .....
discharge, monthly .....
gage heights .....
rating table .....

Hartford, Conn.
Connecticut River at:
description 121
gage heights .....

Holden, Me.
Phillips Lake in:
description 4

Housatonic River at—
Gaylordsville, Conn.:
description .....
discharge .....
discharge, mean daily .....
discharge, monthly .....
gage heights .....
rating table .....

Housatonic River drainage basin:
description .....

Israel River (above South Branch) near—
Jefferson Highlands, N. H.:
description .....
discharge .....
discharge, monthly .....
gage heights .....
rating table .....

rael River (below South Branch) near— Page.
Jefferson Highlands, N. H.:
description 125–126
discharge..... 126
discharge, monthly 128
gage heights..... 127
rating table 127
efferson Highlands, N. H.
Israel River (above South Branch) near:
description 123
discharge..... 123
discharge, monthly 125
gage heights..... 124
rating table 124
Israel River (below South Branch) near:
description 125–126
discharge..... 126
discharge, monthly 128
gage heights..... 127
rating table..... 127
Kennebec River at—
North Anson, Me.:
description 59–60
discharge..... 60
discharge, monthly 62
gage heights..... 61
rating table..... 62
The Forks, Me.:
description 56–57
discharge..... 57
discharge, monthly 59
gage heights..... 58
rating table..... 58
Waterville, Me.:
description 62–63
discharge..... 63
Kennebec River drainage basin:
description 55–56
Lake Cochituate at—
Cochituate, Mass.:
description 105
rainfall 107
yield..... 107
Lawrence, Mass.
Merrimac River at:
description 89–90
flow 90–93
Little River near—
Twin Mountain, N. H.:
description 134–135
discharge..... 135
gage heights..... 135
Machias River near—
Whitneyville, Me.
description 31
discharge..... 32
discharge, monthly 33
gage heights..... 32
rating table 33
Machias River drainage basin:
description 31
Madison, Me.
Sandy River near:
description 71–72
Mattawamkeag, Me. Page.
Mattawamkeag River at:
description 44
discharge..... 45
discharge, monthly 47
gage heights. 45–46
rating table 46
Mattawamkeag River at—
Mattawamkeag, Me.:
description 44
discharge..... 45
discharge, monthly..... 47
gage heights..... 45–46
rating table 46
Merrimac River at—
Franklin Junction, N. H.:
description 86
discharge..... 87
discharge, monthly..... 88
gage heights. 87
rating table. 88
Garvins Falls, New Hampshire:
description 89
Lawrence, Mass.:
description 89–90
flow 90–93
Merrimac River drainage basin:
description 85–86
Messalonskee River at—
Waterville, Me.:
description 72
discharge..... 73
Millinocket, Me.
Penobscot River at—
description 36
discharge..... 37
Moose River near—
Rockwood, Me.:
description 64
gage heights..... 64
Nashua River (South Branch) at—
Clinton, Mass.:
description 108
rainfall 108
yield 108–109
North Anson, Me.
Carrabassett River at:
description 67–68
discharge..... 68
discharge, monthly 70
gage heights..... 69
rating table 70
Kennebec River at:
description 59–60
discharge..... 60
discharge, monthly 62
gage heights..... 61
rating table 62
Orford, N. H.
Connecticut River near:
description 115
discharge..... 116
discharge, monthly 119
gage heights..... 117
rating table 118–119

Pemigewasset River at— Page.
Plymouth, N. H.:
description 93–94
discharge 94
discharge, monthly 97–101
gage heights 95
rating table 96
Penobscot River at—
Millinocket, Me.:
description 36
discharge 37
West Enfield, Me.:
description 37–38
discharge 38
discharge, monthly 40
gage heights 39
rating table 40
Penobscot River (East Branch) at—
Grindstone, Me.:
description 40–41
discharge 41
discharge, monthly 43
gage heights 42
rating table 43
Penobscot River drainage basin:
description 34–36
Phillips Lake in—
Holden and Dedham, Me.:
description 52–53
gage heights 54
Phillips Lake (north outlet) at—
East Holden, Me.:
description 52–53
discharge 53
gage heights 54
Phillips Lake (southeast outlet) near—
Greenlake, Me.:
description 52–53
discharge 54
Piscataquis River near—
Foxcroft, Me.:
description 47–48
discharge 48
discharge, monthly 50
gage heights 48–49
rating table 49
Plymouth, N. H.
Pemigewasset River at:
description 93–94
discharge 94
discharge, monthly 97–101
gage heights 95
rating table 96
Presumpscot River at—
Sebago Lake, Maine:
description 80–81
discharge 81
Presumpscot River drainage basin:
description 80
Quabog River at—
West Warren, Mass.:
description 144
Roach River, Me.
Roach River at:
description 65
gage heights 65
Roach River at— Page.
Roach River, Me.:
description 6
gage heights 6
Rockwood, Me.
Moose River near:
description 6
gage heights 6
Rumford Falls, Me.
Androscoggin River at:
description .....
Russell, Mass.
Westfield River at:
description .....
discharge .....
gage heights .....
Saco River near—
Center Conway, N. H.:
description .....
discharge .....
discharge, monthly .....
gage heights .....
rating table .....
Saco River drainage basin:
description 8
St. Croix River near—
Baring, Me.:
description 2
discharge .....
discharge, monthly .....
gage heights .....
rating table .....
St. Croix River drainage basin:
description 2
St. John River drainage basin:
description 2
Sandy River near—
Madison, Me.:
description 7
Sebago Lake, Maine—
Presumpscot River at outlet of:
description 8
discharge .....
Sharon, Vt.
White River at:
description .....
discharge .....
discharge, monthly .....
gage heights .....
rating table .....
Shelburne, N. H.
Androscoggin River at:
description .....
discharge .....
gage heights .....
Shetucket River near—
Willimantic, Conn.:
description .....
discharge .....
gage heights .....
Sudbury River at—
Framingham, Mass.:
description .....
run-off .....
Suncook River at—
East Pembroke, N. H.:
description .....

Sunderland, Mass. Page.
Connecticut River at:
description 120
discharge 120
gage heights 121
Swift River at—
West Ware, Mass.:
description 144
Thames River drainage basin:
description 111
The Forks, Me.
Dead River near:
description 66
discharge 66
gage heights 67
Kennebec River at:
description 56–57
discharge 57
discharge, monthly 59
gage heights 58
rating table 58
Twin Mountain, N. H.
Little River near:
description 134–135
discharge 135
gage heights 135
Zealand River near:
description 131–132
discharge 132
discharge, monthly 134
gage heights 133
rating table 133
Wallagrass, Me.
Fish River at:
description 21–22
discharge 22
gage heights 23
Ware, Mass:
Ware River near:
description 142
discharge 143
gage heights 143
Ware River at and near—
Gilbertville, Mass.:
description 143
Ware, Mass.:
description 142
discharge 143
gage heights 143
Waterville, Me.
Kennebec River at:
description 62–63
discharge 63
Messalonskee River at:
description 72
discharge 73
West Enfield, Me.
Penobscot River at:
description 37–38
West Enfield, Me.—Continued. Page.
Penobscot River at—Continued.
discharge 38
discharge, monthly 40
gage heights 39
rating table 40
West Hopkinton, N. H.
Contoocook River at:
description 101–102
discharge 102
discharge, monthly 104
gage heights 103
rating table 104
West Ware, Mass.
Swift River at:
description 144
West Warren, Mass.
Quabog River at:
description 144
Westfield River at—
Russell, Mass.:
description 145
discharge 146
gage heights 146
White River at—
Sharon, Vt.:
description 136
discharge 136
discharge, monthly 138
gage heights 137
rating table 137
Whitneyville, Me.
Machias River near:
description 31
discharge 32
discharge, monthly 33
gage heights 32
rating table 33
Willimantic, Conn.
Shetucket River near:
description 112
discharge 112
gage heights 113
Winchester, N. H.
Ashuelot River at:
description 138
discharge 139
gage heights 139
Woonsocket, R. I.
Blackstone River at:
description 109–110
discharge 110
gage heights 110–111
Zealand River near—
Twin Mountain, N. H.:
description 131–132
discharge 132
discharge, monthly 134
gage heights 133
rating table 133

O

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

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94. Bulletin No. 131; Sixteenth Annual Report, Part II.
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UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

Water-Supply and Irrigation Paper No. 125 Series P, Hydrographic Progress Reports, 30

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL
BY
R. E. HORTON, N. C. GROVER, and JOHN C. HOYT

PART II.—Hudson, Passaic, Raritan, and Delaware River Drainages

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

CONTENTS.

	Page.
r of transmittal	7
duction	9
eration and acknowledgments	18
son River drainage basin	19
Hudson River at Fort Edward, N. Y	19
Hudson River at Mechanicsville, N. Y	22
Indian River at Indian Lake, Hamilton County, N. Y	24
Hoosic River at Buskirk, N. Y	24
Mohawk River at Little Falls, N. Y	26
Mohawk River at Dunsbach Ferry Bridge, N. Y	29
Oriskany Creek near Oriskany, N. Y	32
Starch Factory Creek near New Hartford, N. Y	35
Sylvan Glen Creek near New Hartford, N. Y	37
Graefenberg Creek near New Hartford, N. Y	39
Reels Creek and Johnston Brook near Deerfield, N. Y	41
Nail Creek at Utica, N. Y	45
West Canada Creek at Twin Rock Bridge, N. Y	46
East Canada Creek at Dolgeville, N. Y	50
Schoharie Creek at Prattsville, N. Y	54
Batavia Kill near Prattsville, N. Y	59
Catskill Creek at South Cairo, N. Y	60
Esopus Creek near Olivebridge, N. Y	63
Esopus Creek at Kingston, N. Y	66
Wappinger Creek near Wappinger Falls, N. Y	70
Croton River at old Croton dam, New York	71
Miscellaneous measurements	73
aic River drainage basin	73
Passaic River at Millington, N. J	74
Passaic River near Chatham, N. J	76
Pompton River at Pompton Plains, N. J	78
Ramapo River near Mahwah, N. J	79
Wanaque River at Wanaque, N. J	82
Rockaway River near Boonton, N. J	84
tan River drainage basin	84
Raritan River (South Branch) at Stanton, N. J	85
Raritan River at Finderne, N. J	87
Raritan River at Boundbrook, N. J	90
Raritan River (North Branch) near Pluckemin, N. J	91
Millstone River at Millstone, N. J	93
ware River drainage basin	94
Delaware River (West Branch) at Hancock, N. Y	96
Delaware River (East Branch) at Hancock, N. Y	98
Delaware River at Lambertville, N. J	99
Lehigh River near South Bethlehem, Pa	101
Musconetcong River near Bloomsbury, N. J	102
Tohickon Creek at Point Pleasant, Pa	104
Neshaminy Creek at forks, Pennsylvania	105
Schuylkill River near Philadelphia, Pa	107
Perkiomen Creek at Frederick, Pa	108
x	111

ILLUSTRATIONS.

Page.

I. Map showing location of principal gaging stations in the United States 10

II. Price current meters, with buzzers 12

III. Cable station, showing section of the river, car, gage, etc 11

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., May 4, 1905.

SIR: I transmit herewith the manuscript of Part II of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of Mississippi River.

The larger part of the original data for this report was collected under the direction of district hydrographers R. E. Horton and N. C. Grover. Mr. Horton had charge of the work in New York, and was assisted by C. C. Covert and H. R. Beebe. The computations for that portion of the report were made under the direction of Mr. Horton. Mr. Grover had charge of the work in New Jersey, and was assisted by F. H. Tillinghast and Frank H. Brundage. A limited amount of the data was collected by other parties, as shown in the list of acknowledgments. The assembling of the data and its preparation for publication were done under the direction of J. C. Hoyt, who has been assisted by R. H. Bolster, Robert Follansbee, W. E. Hall, F. H. Tillinghast, H. D. Padgett, and A. H. Horton.

I request that this manuscript be published as one of the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL,
Chief Engineer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

›GRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART II.

By R. E. Horton, N. C. Grover, and J. C. Hoyt.

INTRODUCTION.

› hydrographic work of the United States Geological Survey les the collection of facts concerning and the study of conditions ing the behavior of water from the time it reaches the earth as ›r snow until it joins the oceans or great navigable rivers. These ›igations became a distinct feature of the work of the Survey in .ll of 1888, when an instruction camp was established at Embudo, ex. Since that date the work has been continually and gradually ded as larger funds became available. The first distinctive ›priation for gaging streams was made by the act of August 18, which contained an item of $12,500, "for gaging the streams etermining the water supply of the United States, including the igation of underground currents and artesian wells in the arid ›miarid sections." (Digest of Appropriations for 1895, p. 270.) ce that time a similar act has been passed each year and the priations have gradually increased, as shown in the following

Annual appropriations for hydrographic surveys.

nding June 30, 1895	$12,500
nding June 30, 1896	25,000
nding June 30, 1897	50,000
nding June 30, 1898	50,000
nding June 30, 1899	50,000
nding June 30, 1900	50,000
nding June 30, 1901	100,000
nding June 30, 1902	100,000
nding June 30, 1903	200,000
nding June 30, 1904	200,000
nding June 30, 1905	200,000
nding June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

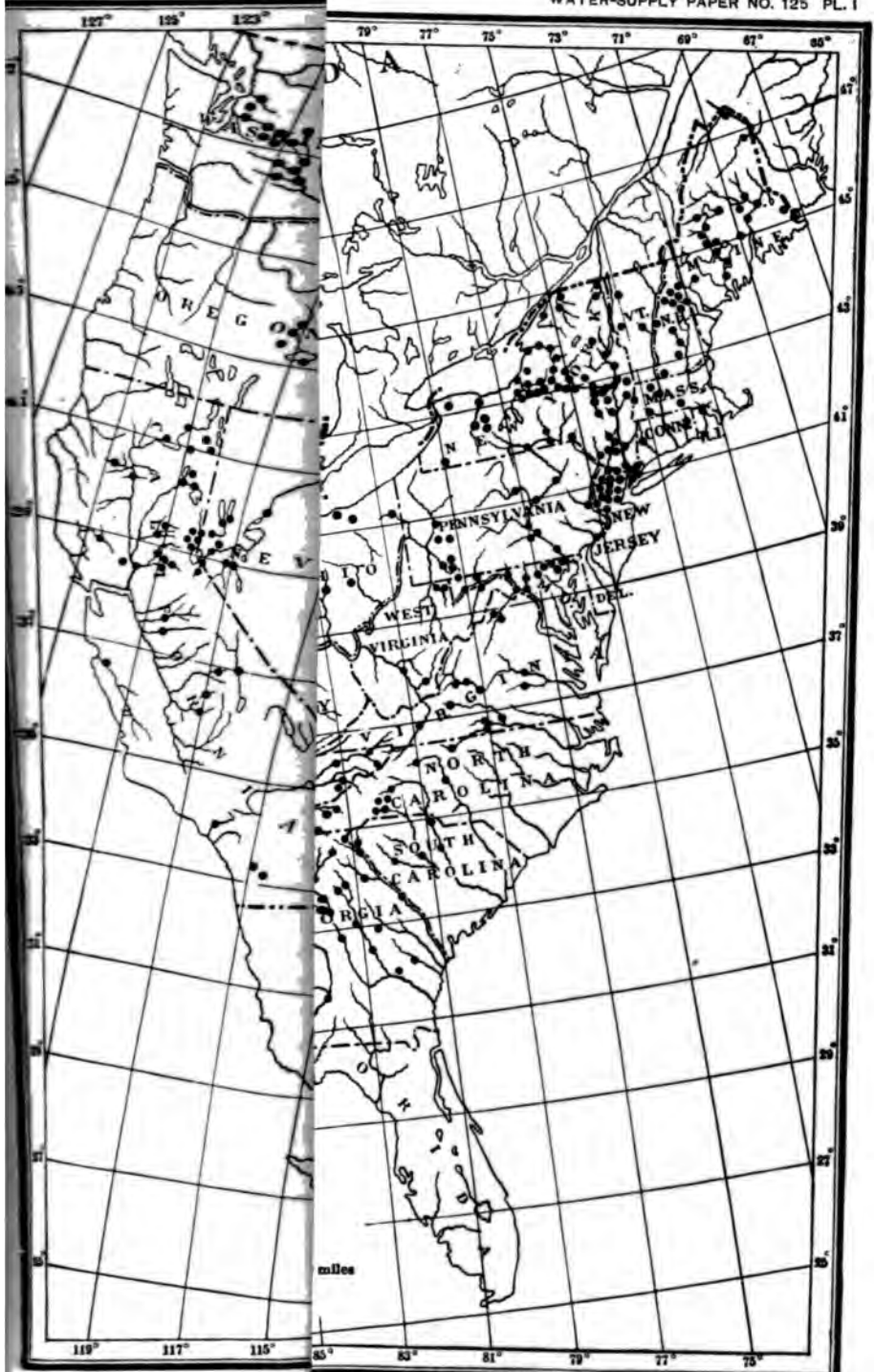
As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time as typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observation.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations, and, second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is



MA AINED DURING 1904.

ift some appliance, generally a secondary cable, is necessary to hold e meter below the surface.

Gaging stations are generally located at bridges, if the channel contions are satisfactory, as from them the meter can be easily maniputed, and the cost of the equipment is comparatively small. The ations are located as far as possible at points where the channel is raight, both above and below the gaging section, and where there e no cross currents, backwater, or boils. The bed of the stream ould be as clear as possible from large projections and of a permaent character. The banks should be high, and should overflow at gh stages only. At stations with shifting beds more measurements e made, and special methods of computing daily discharges are ployed. Great care is taken in the selection and equipment of ging stations in order that the data may have the required degree accuracy.

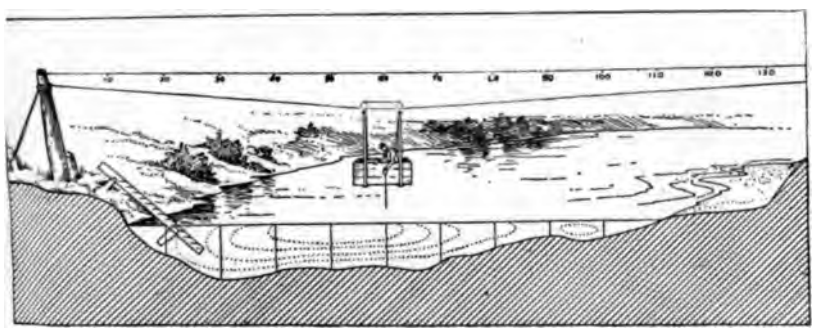


FIG. 1.—Cable station, showing section of river, car, gage, etc.

On many of the larger rivers, where water power is developed by lams, estimates of flow are obtained by observing the head on the rest and using a weir formula. On the smaller streams sharp-crested eirs are in some cases erected.

The principal instrument used in stream-measurement work is the rrent meter, by which the velocity of the flow of water is deterined. After years of experience the Survey has adopted the Price rrent meter for general work. This meter, as is shown on Pl. II, made in two sizes, known as the large and small Price. The small ice has been largely developed by the officers of the Survey, using e Price acoustic meter as a basis.

A discharge measurement is the determination of the quantity of ater flowing past a certain point at a given time. This quantity is e product of two factors: (1) The mean velocity, which is the funcn of the cross section, surface slope, wetted perimeter, and roughss of bed; (2) the area, which depends upon the permanency of the d and the fluctuations of the surface, which govern the depth.

swift some appliance, generally a secondary cable, is necessary to hold the meter below the surface.

Gaging stations are generally located at bridges, if the channel conditions are satisfactory, as from them the meter can be easily manipulated, and the cost of the equipment is comparatively small. The stations are located as far as possible at points where the channel is straight, both above and below the gaging section, and where there are no cross currents, backwater, or boils. The bed of the stream should be as clear as possible from large projections and of a permanent character. The banks should be high, and should overflow at high stages only. At stations with shifting beds more measurements are made, and special methods of computing daily discharges are employed. Great care is taken in the selection and equipment of gaging stations in order that the data may have the required degree of accuracy.

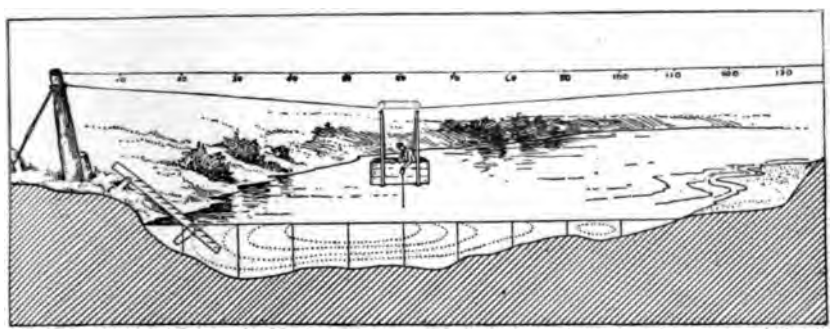


FIG. 1.—Cable station, showing section of river, car, gage, etc.

On many of the larger rivers, where water power is developed by dams, estimates of flow are obtained by observing the head on the crest and using a weir formula. On the smaller streams sharp-crested weirs are in some cases erected.

The principal instrument used in stream-measurement work is the current meter, by which the velocity of the flow of water is determined. After years of experience the Survey has adopted the Price current meter for general work. This meter, as is shown on Pl. II, is made in two sizes, known as the large and small Price. The small Price has been largely developed by the officers of the Survey, using the Price acoustic meter as a basis.

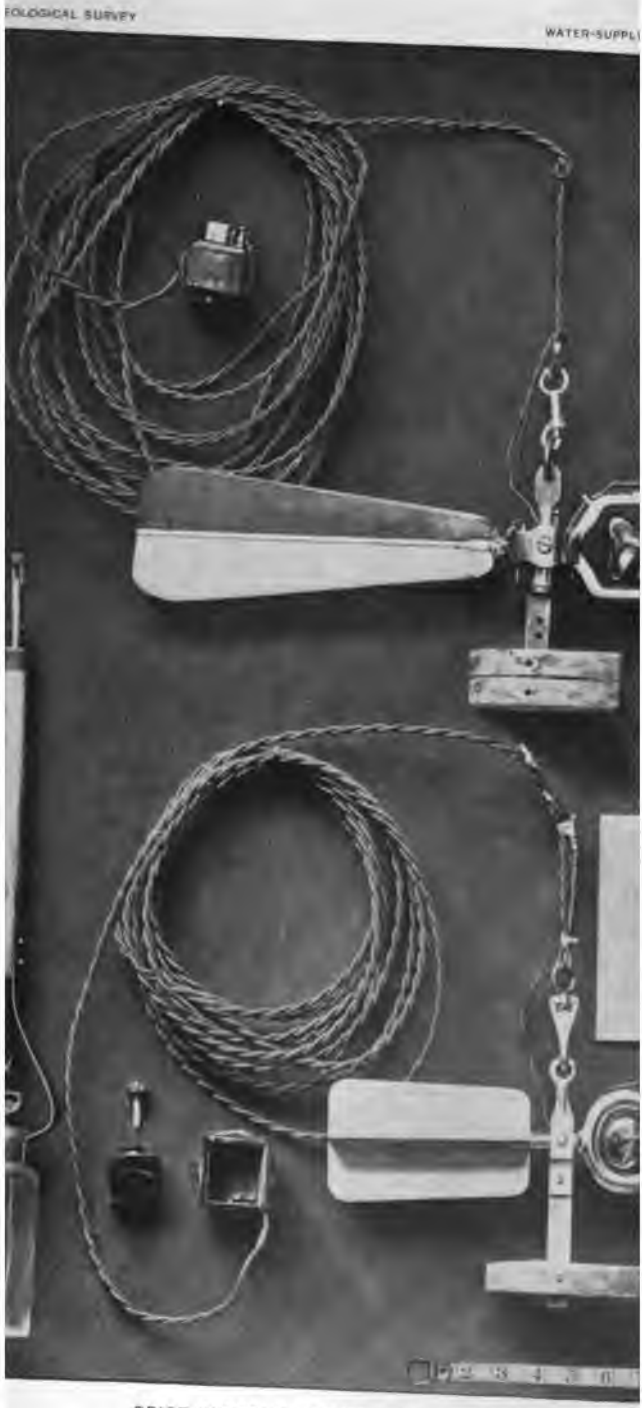
A discharge measurement is the determination of the quantity of water flowing past a certain point at a given time. This quantity is the product of two factors: (1) The mean velocity, which is the function of the cross section, surface slope, wetted perimeter, and roughness of bed; (2) the area, which depends upon the permanency of the bed and the fluctuations of the surface, which govern the depth.

In making the measurement an arbitrary number of points are laid off perpendicular to the thread of the stream (see fig. 1). These points are usually at regular intervals varying from 2 to 20 feet, depending upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity, or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenth depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between 0.94 and 1.04, with a mean for the 910 observations of 1.00. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from 0.85 to 0.95, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements, or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity-curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth



PRICE CURRENT METERS, WITH BUZZERS.

ıto the area bounded by this mean velocity curve and the initial line. 'wing to the length of time it takes to make these measurements they re seldom used except for determining coefficients for purposes of ›mparison and for measurements under ice.

In the second multiple-point method the meter is held from 0.5 to 1 ›ot below the surface and about 0.5 foot above the bottom, and the ıean of the velocities at these two points is taken as the mean velocity ›r that vertical. This method is not well adapted for general work, ; the roughness of the bottom disturbs the velocity at that point. or shallow streams with comparatively smooth beds good results are ›tained by this method. In the third multiple-point method the ıeter is held at mid depth, 0.5 foot below the surface and 0.5 foot ›ove the bottom, and the mean velocity is determined by dividing the ım of the top velocity, twice the mid-depth velocity, and the bottom elocity by 4.

The vertical integration method consists in moving the meter at a .ow, uniform speed from the surface to the bottom and back again to ıe surface. The number of revolutions and the time taken in the peration is noted, and the mean velocity is found by dividing the umber of revolutions by the number of seconds taken in the run. 'his method has the advantage in that the velocity at each point of ıe vertical is measured twice. It is well adapted for measurements nder ice and as a check on the point methods.

The area, which is the other factor for determining the discharge of ıe stream, depends upon the stage of the river, which is taken on a age, and the general contour of the bed of the stream, which is found y sounding. The soundings are usually taken at each measuring ›int at the time of the discharge measurement, either by using the eter and cable or by a special sounding line or rod. For stations ith permanent beds standard cross sections are usually taken during w water. These sections serve to check the soundings which are taken the time of the measurements, and from them any change which ay have taken place in the bed of the stream can be detected. They 'e also used for obtaining the area for use in high-water measurement ›mputations, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed veloci- ›s and depths at the various points of measurements the measuring ction is divided into elementary strips, as shown in fig. 1, and the ean velocity, area, and discharge are determined separately for either single or double strip. The total discharge and area are the sums f those for the various strips, and the mean velocity is obtained by ividing the total discharge by the total area.

The volume of water flowing in a stream is known as run-off. In ‹pressing it various units are used, depending upon the kind of work ›r which the data are needed. Those used in this report are "second-

feet," "acre-feet," "run-off per square mile," and "run-off in depth in inches," and may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The "acre-foot" is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area on the assumption that the run-off is uniformly distributed.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow per second.

The base data for computing the daily discharge of a stream are the daily gage heights and the various discharge measurements, of which there should be a sufficient number to cover the range of stage. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights. (2 and 3 depend on 1.)

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent or practically permanent beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds, the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissas.

Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. The mean velocity and area determined for each discharge measurement are also plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mean velocity and the area at various stages as determined by these curves. These curves of mean velocity and area are of special value in determining the location of the rating curve for stages at which actual discharge measurements are not available and for extending the discharge curve outside the limits of the measurements. In the preparation of the rating table the discharge for each tenth or half-tenth on the gage is found from the curve. The first and second differences of these discharges are then taken and adjusted according to the law that they shall either be constant or increasing, never decreasing. The discharges in the table are then changed in accordance with these adjusted differences. In making up the station rating curve the individual discharge measurements and the conditions under which they were taken are carefully studied, in order that proper weight shall be given to each measurement. Rating curves in general take the form of a parabola, and as a rule the high-water portion of the curve approaches a straight line. For stations of permanent character the results of the measurements from year to year should be within 5 per cent of the curve, with the exception of those taken during high water, when the probable error may be as high as 10 per cent.

The determination of the daily discharge of streams with changeable beds is difficult, and unless frequent discharge measurements are made the results obtained are only roughly approximate. For streams with continually shifting beds, such as Colorado River and the Rio Grande, discharge measurements are made every two or three days, and the discharges for the intervening days are obtained by interpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed during floods, station rating curves and tables can be prepared for the periods between changes, and satisfactory results can be obtained with two or three measurements a month, providing measurements are taken soon after the changes occur.

In determining the flow for periods when the streams are frozen, special rating curves and tables have to be prepared from measurements taken under these conditions. The methods of constructing these curves and tables are the same as for open sections. The discharge measurements, however, are either taken by integration in verticals or by the vertical velocity-curve method, as sufficient experiments have not been made on ice-covered streams to determine the laws which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar Year 1904, of which this is Part II, is published in a series of twelve Water-Supply Papers, Nos. 124–135, inclusive, under the following subtitles:

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha rivers, and Eastern Gulf of Mexico drainage.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meramec, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainage in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations, and such other information that has been collected that has a direct bearing on these data, including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage heights gives for each day the mean height of the surface of the river as found from the mean of the gage read-

ings taken on that day. At most of the stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated run-off the column headed "Maximum" gives the mean flow for the day when the mean gage height was the highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" gives the average flow for each second during the month. Upon this mean the computations for the three remaining columns which are defined on page 14 are based.

In the computations for the tables of this report the following general and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and money is imperative.

2. All items of computation should, in general, be expressed by at least two and by not more than four significant figures.

3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose per cent of error is 5 times the average per cent error of all the other measurements should be rejected.

4. In reducing the number of significant figures, or the number of decimal places, by dropping the last figure, the following rules apply:

(a) When the figure in the place to be rejected is less than 5, drop it without changing the preceding figure. Example: 1,827.4 becomes 1,827.

(b) When the figure in the place to be rejected is greater than 5, drop it and increase the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(c) When the figure in the place to be rejected is 5, and it is preceded by an even figure, drop the 5. Example: 1,828.5 becomes 1,828.

(d) When the figure in the place to be rejected is 5, and it is preceded by an odd figure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 1,828.

5. In constructing and applying rating tables a maximum limit of one-half per cent error should seldom be exceeded.

Special rules for computation.

1. Rating tables are to be constructed as close as the data upon which they are based will warrant. No decimals are to be used when the discharge is over 50 second-feet.

2. Daily discharges shall be applied directly to the gage heights as they are tabulated.

3. Monthly means are to be carried out to one decimal place when the quantities are below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the monthly mean shall be a significant figure. This also applies to the yearly mean.

4. Second-feet per square mile and depth in inches for the individual months shall be carried out at least to three significant figures, except in the case of decimals,

where the first significant figure is preceded by one or more naughts (0), when the quantity shall be carried out to two significant figures. Example: 1.25; .125; .012; .0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of these reports (from 1888-1903) is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive.
West of Mississippi River, Water-Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at prices slightly above cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the names of the resident hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

New Jersey.—District hydrographer, E. G. Paul during first half and N. C. Grover[a] during the last half of the year, assisted by H. D. Comstock.

New York.—District hydrographer, R. E. Horton,[b] assisted by C. C. Covert. Records have been furnished by the following: E. A. Fisher, city engineer, and John F. Skinner, special assistant engineer, Rochester, N. Y.; T. P. Yates, Waverly, N. Y.; William S. Bacot, Utica, N. Y.; International Paper Company, Fort Edward, N. Y.; Schroon River Pulp and Paper Company, Warrensburg, N. Y.; Duncan Company, R. P. Bloss, Mechanicsville, N. Y.; George Beebe, deputy city engineer, Syracuse, N. Y. Special acknowledgment is made of the interest and assistance of Hon. Edward A. Bond, State engineer, and William Pierson Judson, deputy State engineer.

Pennsylvania.—District hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year, assisted by H. D. Comstock. Special acknowledgment is due to Mr. John E. Codman for the records of flow of the streams in the vicinity of Philadelphia.

HUDSON RIVER DRAINAGE BASIN.

HUDSON RIVER AT FORT EDWARD, N. Y.

This station, which is located at the dam of the International Paper Company, was established in 1895, in connection with the upper Hudson storage surveys.[c] The dam is of framed timber on slate-rock foundation, and has but little leakage. The crest is straight, very nearly level, and 587.6 feet in length. The crest gage zero stands at the level of the lip of the dam proper. Flashboards are usually maintained on the dam from 15 inches to 18 inches in height. A record is kept of the height of flashboards, and of the times of their setting and removal.

There are 62 water wheels in the adjoining mill. These are nearly all of modern types, which have been tested at the Holyoke flume. A record is kept of the daily run of each in hours, as well as of the working head, which is usually 19 feet. The discharge through the turbines is taken from diagrams expressing the flow as a function of the working head and number of wheel-hours run.

In the winter of 1896–97 a flood spillway was cut around the south end of the dam, over which the water begins to flow whenever it reaches the level of the crest of the flashboards. The profile of the spillway is very irregular and causes some uncertainty in the calculated flow during times of high water.

Whenever the flashboards are off from the main dam the flow is computed by means of coefficients derived from the United States Geological Survey experiments on a model dam of similar cross section.

With the flashboards on, the flow has been computed by the Francis formula for the thin-edged weir. During the dry season but little water passes over the dam, the entire flow being employed to drive the turbines.

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[a] The office of the district hydrographer for New Jersey and Pennsylvania is at the United States Geological Survey, Washington, D. C.

[b] The office of the district hydrographer for New York is 75 Arcade, Utica, N. Y.

[c] See Report of State Engineer and *Surveyor of New York*, 1895, p. 105.

A new and accurate profile of the crest of the dam, obtained in 1903, has been used to determine the discharge for 1903 and 1904.

During the navigation season water is diverted from Hudson River at Glens Falls feeder dam, 7 miles above Fort Edward, for the supply of Champlain Canal.

The Champlain Canal feeder was measured at Glens Falls on August 25, 1904, giving a discharge of 302 second-feet.

The drainage area tributary to the Hudson above Fort Edward is 0.62 of that of the same stream above Mechanicsville gaging station. The principal intervening tributaries are Hoosic River and Batten Kill, having drainage areas of 730 and 460 square miles, respectively.[a]

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Mean daily discharge, in second-feet, of Hudson River at Fort Edward, N. Y., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	4,460	[b]6,800	[b]9,500	10,640	3,840	2,380	6,460	2,070	5,990	2,940	[b]4,430	[b]2,840
2	4,260	6,460	12,680	10,640	1,640	2,310	6,460	[b]3,820	5,810	2,940	5,140	4,520
3	2,100	5,980	10,800	8,970	[b]2,160	2,510	6,160	4,800	5,240	1,660	4,590	3,890
4	[b]3,820	5,980	10,800	6,840	4,250	2,350	[b]6,050	4,800	4,540	1,370	4,860	4,020
5	4,980	6,840	9,560	[b]6,330	4,560	2,350	[b]6,050	5,060	1,430	2,940	4,860	2,200
6	4,810	6,840	8,880	11,840	4,420	1,520	5,410	5,810	[b]2,840	3,440	4,860	[a]710
7	4,460	4,300	8,040	10,800	3,510	[b]600	4,550	5,990	[b]3,420	3,810	2,870	2,990
8	4,530	[b]5,130	[b]14,030	10,040	4,560	2,920	4,390	4,090	3,580	4,060	[b]2,460	3,880
9	4,170	5,980	17,680	8,880	2,250	3,260	4,220	[b]5,130	3,720	4,440	4,440	3,880
10	1,870	4,980	17,680	8,880	[b]1,980	3,260	3,800	5,810	3,720	16,600	4,300	3,630
11	[b]3,820	4,810	17,520	5,750	3,460	3,260	2,010	5,990	3,720	[b]16,340	4,300	3,750
12	3,620	6,160	17,520	[b]6,800	2,950	3,880	[b]2,460	6,290	2,050	13,500	4,300	1,940
13	3,840	6,160	17,520	7,820	2,440	5,060	4,030	7,250	[b]2,460	10,800	4,300	[b]2,460
14	3,860	4,000	15,430	7,210	2,440	[b]6,050	4,200	7,040	3,280	10,800	2,460	4,060
15	4,100	[b]6,330	[b]17,360	4,980	2,830	12,050	4,200	4,090	2,780	8,420	[b]2,460	3,810
16	4,260	5,660	16,460	5,260	1,660	7,350	4,310	[b]6,050	2,390	7,200	4,060	3,810
17	2,100	5,260	14,380	5,260	[b]1,260	5,910	4,200	4,290	2,700	3,380	4,200	3,940
18	[b]2,460	4,980	14,380	6,840	2,670	9,490	2,130	3,540	3,080	8,120	4,620	3,810
19	3,540	4,710	15,540	[b]6,800	2,670	9,120	[b]2,460	3,360	1,740	11,320	4,260	2,000
20	3,380	4,710	18,020	5,260	3,830	3,710	3,690	[b]780	[b]2,460	10,320	4,260	[b]2,160
21	3,540	2,550	17,380	4,260	[b]3,540	11,550	3,690	[b]360	3,030	10,320	1,880	4,560
22	4,130	6,960	[b]23,960	4,210	2,920	16,640	4,310	1,640	2,890	8,880	[b]2,460	4,000
23	4,170	5,710	27,710	4,040	1,330	15,860	5,980	[b]3,820	2,390	8,880	[b]4,300	4,000
24	2,100	4,010	[b]35,780	4,040	[b]990	14,680	6,460	4,640	2,640	5,520	[b]4,300	4,000
25	[b]3,820	4,010	[b]34,890	1,750	[b]2,070	13,690	4,170	4,390	2,640	4,880	[b]2,460	[b]3,820
26	4,360	4,010	28,760	[b]2,840	[b]1,610	13,080	[b]6,050	4,840	1,540	4,980	[b]2,460	[b]3,820
27	4,260	2,010	22,060	3,740	[b]1,610	11,880	6,460	4,840	[b]2,460	4,980	[b]2,840	[b]3,820
28	4,100	[b]5,320	15,750	3,740	[b]1,430	10,940	4,710	4,840	2,890	4,530	[b]2,8[illegible]	4,400
29	4,080	.....	[b]18,060	3,740	1,610	10,040	4,030	2,770	2,640	4,060	[b]3,210	4,400
30	4,360	.....	10,290	3,740	1,220	7,820	4,030	[b]5,130	2,390	4,080	[b]3,210	4,400
31	2,200	.....	9,910	.....	[b]1,670	.....	4,030	5,740	.....	1,900	.....	4,400

[a] Water power of upper Hudson River is described in Report of New York State Engineer and Surveyor, 1895, pp. 124-164.

[b] Sundays, holidays, and for repairs, mills shut down.

Mean daily discharge, in second-feet, of Hudson River at Fort Edward, N. Y., etc.—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
1	6,620	3,020	3,080	13,240	a21,380	4,020	3,030	3,620	2,210	3,310	5,050	2,410
2	4,430	2,750	3,120	10,800	22,660	4,430	2,310	2,200	2,220	a7,450	4,960	2,530
3	a3,210	2,900	3,380	a13,330	21,540	4,130	830	2,830	1,770	6,180	4,160	1,140
4	5,960	2,640	3,490	13,540	20,120	3,890	(a)	2,340	a1,200	4,820	3,920	a2,190
5	5,870	2,640	2,610	14,080	19,740	a9,200	3,030	2,330	a2,810	5,190	1,870	2,710
6	5,620	1,910	a2,460	16,340	17,320	8,890	3,420	4,150	3,310	4,490	a2,800	1,810
7	5,990	a2,460	3,950	16,340	13,630	7,980	3,030	a3,990	2,190	3,480	3,670	2,160
8	6,120	3,610	4,200	18,380	a16,120	6,000	2,780	3,860	3,010	1,520	3,260	2,720
9	4,790	4,280	7,420	18,370	11,820	5,690	2,210	2,340	2,530	a3,010	3,120	2,160
10	a2,460	4,530	8,040	a27,630	11,820	11,240	(a)	2,520	1,750	3,620	2,910	1,020
11	5,460	4,440	8,420	31,620	8,410	9,810	2,410	2,720	a2,010	3,860	3,280	a1,730
12	5,210	4,360	7,010	29,480	6,300	a13,400	2,160	2,810	2,780	5,510	2,070	2,740
13	5,120	3,020	a7,820	26,560	6,300	8,440	2,280	1,940	2,220	5,380	a2,800	2,160
14	5,120	a5,130	4,900	25,380	4,860	7,350	2,780	a1,730	2,840	5,050	3,980	2,530
15	5,370	4,030	4,620	17,320	a10,090	6,940	2,910	2,230	2,230	2,680	2,660	2,160
16	4,290	3,900	4,980	12,630	6,300	6,000	2,030	2,060	2,230	a3,990	2,660	2,160
17	a2,160	3,680	4,170	a11,680	7,190	4,430	(a)	1,460	1,910	4,290	2,660	1,220
18	5,030	3,090	4,260	11,280	7,390	2,810	2,410	1,770	a1,510	3,560	2,410	a1,730
19	4,650	2,430	2,840	11,000	7,390	a1,700	2,410	1,950	3,550	3,220	1,220	2,190
20	4,410	1,840	a2,460	9,280	7,620	3,180	1,910	1,280	2,710	3,510	a2,490	2,600
21	4,160	a3,820	4,360	8,820	6,330	3,180	2,160	a450	2,730	3,730	3,080	2,030
22	4,520	3,630	4,210	7,190	a9,540	3,180	1,780	6,330	2,730	14,020	2,030	1,910
23	3,550	3,540	5,980	4,750	7,190	3,180	1,710	6,820	2,740	a20,510	2,580	2,060
24	a3,210	3,790	11,280	a10,090	6,300	3,160	(a)	6,660	2,020	16,780	1,640	980
25	6,240	3,930	13,540	15,680	5,950	1,040	1,780	4,840	a2,980	13,840	2,230	a2,740
26	6,240	3,840	11,820	15,680	5,950	a1,540	1,410	4,450	4,540	11,160	1,140	a2,660
27	6,120	2,390	a16,810	13,540	6,300	3,000	1,410	2,450	4,350	9,480	a2,010	2,990
28	6,120	a3,820	16,340	13,540	4,860	2,440	1,660	a2,030	4,680	7,980	3,580	3,220
29	6,120	3,260	13,240	21,540	a6,000	1,180	2,160	2,660	4,680	4,850	2,780	3,740
30	4,920	.....	13,240	21,740	5,950	1,280	1,480	2,320	4,150	a7,450	2,280	3,740
31	a2,460	.....	13,240	.....	5,300	.....	(a)	2,270	.....	5,720	.....	1,560

a Sundays, holidays, for repairs, mills shut down.

Estimated monthly discharge of Hudson River at Fort Edward, N. Y., for 1903 and 1904.

[Drainage area, 2,800 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
January	4,980	1,870	3,728	1.33	1.53
February	6,960	2,010	5,238	1.87	1.95
March	35,780	8,040	17,040	6.09	7.02
April	11,840	1,750	6,398	2.28	2.54
May	4,560	990	2,561	.915	1.05
June	16,640	600	7,184	2.57	2.87
July	6,460	2,010	4,554	1.63	1.88
August	7,250	360	4,486	1.60	1.84
September	5,990	1,430	3,080	1.10	1.23
October	16,600	1,370	6,691	2.39	2.76
November	5,140	1,880	3,733	1.33	1.48
December	4,560	710	3,546	1.27	1.46
The year	35,780	360	5,687	2.03	27.61
1904.					
January	6,620	2,160	4,889	1.75	2.02
February	5,130	1,840	3,403	1.22	1.27
March	16,810	2,460	7,009	2.50	2.88
April	31,620	4,750	16,030	5.72	6.38
May	22,660	4,860	10,250	3.66	4.22
June	13,400	1,040	5,090	1.82	2.03
July, 26 days	3,420	830	[a] 2,211	.790	.911
August	6,820	450	2,949	1.05	1.21
September	4,680	1,200	2,753	.983	1.10
October	20,510	1,520	6,440	2.30	2.65
November	5,050	1,140	2,843	1.02	1.14
December	3,740	980	2,248	.803	.926
The year	31,620	450	5,510	1.97	26.74

[a] Mean for 26 days taken as mean for entire month.

HUDSON RIVER AT MECHANICSVILLE, N. Y.

A record of the flow of Hudson River at Mechanicsville has been kept by the Duncan Company, beginning December, 1888. The record includes two daily readings of the depth on the crest of the dam, and a continuous record of the run of the water wheels in the adjoining paper mill. The accompanying tables show the monthly and daily

ean flow at Mechanicsville, computed by Mr. R. P. Bloss, the engi-
er of the company. The flow over the dam has heretofore been
mputed by the Francis formula for the Merrimac dam:

$$Q=3.012\ L\ H^{1.53}.$$

L being 794 feet. H=depth on crest of dam in feet. The same
rmula has been used in all cases, whether flashboards are on or off.
The water supply of Champlain Canal is drawn from Hudson River,
ove Mechanicsville; the gagings at Mechanicsville do not therefore
present precisely the natural yield of the drainage basin.

During 1904 the dam has been increased in height by the addition
f a rounded concrete crest, raised to the height of the flashboards
rmerly used. A new apron has also been constructed. These
hanges have caused a break in the record. A new discharge table for
e dam is being prepared, using coefficients derived from the experi-
ents of the United States Geological Survey at Cornell University,
nd the record will be continued as formerly.

The observations at this station during 1904 have been made under
e direction of R. E. Horton, district hydrographer.

m daily discharge, in second-feet, of Hudson River at Mechanicsville, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
.....	4,410	5,770	5,770	17.....	7,140	5,580	.....
.....	3,970	4,730	4,930	18.....	5,640	5,500	.....
.....	5,550	4,320	6,030	19.....	5,510	4,270	.....
.....	5,450	4,370	11,180	20.....	5,850	5,320	.....
.....	5,350	3,560	9,130	21.....	4,600	6,660	.....
.....	5,250	3,980	.....	22.....	3,390	7,310	.....
.....	4,330	5,500	.....	23.....	9,310	11,850	.....
.....	4,910	15,130	.....	24.....	12,970	9,780	.....
.....	4,930	9,910	.....	25.....	9,340	7,770	.....
.....	6,920	8,020	.....	26.....	6,800	6,700	.....
.....	5,870	7,680	.....	27.....	5,790	6,290	.....
.....	5,780	7,770	.....	28.....	5,190	6,450	.....
.....	4,730	7,270	.....	29.....	4,770	6,550	.....
.....	4,840	8,060	.....	30.....	5,070	.....	.....
.....	4,550	7,380	.....	31.....	5,910	.....	.....
.....	5,840	5,410	.....				

Estimated monthly discharge of Hudson River at Mechanicsville, N. Y., for 1904.

[Drainage area, 4,500 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
nuary	12,970	4,330	5,805	1.29	1.49
bruary	15,130	4,270	6,858	1.52	1.64
arch, 5 days	11,180	4,930	7,408	1.65	.307

INDIAN RIVER AT INDIAN LAKE, HAMILTON COUNTY, N. Y.

A record of the stage of water in Indian Lake reservoir, located in the upper Hudson River drainage basin, as described in preceding reports, has been continued.[a] The reported stage of water in the reservoir is shown in the table below. The reservoir gates were not opened until August 13 and were closed September 28, 1904. They were again opened November 22 and remained open until December 31.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Stage of water in Indian Lake reservoir, Hamilton County, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16.08	10.58	7.67	10.83	26.25	33.25	34.21	29.50	26.08	27.92	28.50	25.95
2	15.96	10.37	7.67	11.00	27.50	33.33	34.25	29.25	25.67	27.75	28.38	25.79
3	15.83	10.17	7.63	11.42	28.67	33.42	34.25	29.08	25.25	27.62	28.25	25.41
4	15.71	9.96	7.63	11.67	29.83	33.33	34.25	28.83	25.08	27.50	28.16	25.17
5	15.58	9.58	7.58	11.92	30.83	33.17	34.25	28.58	24.75	27.42	28.00	24.91
6	15.46	9.37	7.58	12.17	31.75	33.08	34.25	28.33	24.42	27.42	27.88	24.62
7	15.33	9.25	7.58	12.50	32.58	33.17	34.25	28.33	24.08	27.38	27.75	24.25
8	15.21	9.25	7.58	13.00	33.33	33.25	34.25	28.33	23.75	27.33	27.67	23.91
9	15.04	9.21	7.58	13.67	33.83	33.83	34.25	28.25	23.42	28.08	27.58	23.58
10	14.92	9.08	7.58	14.58	34.17	34.42	34.25	28.08	23.08	29.08	27.50	23.25
11	14.75	8.92	7.58	15.50	34.42	34.58	34.21	27.92	22.75	29.83	27.42	22.91
12	14.58	8.75	7.58	16.25	34.58	34.67	34.17	27.83	22.42	30.08	27.33	22.67
13	14.42	8.67	7.63	16.67	34.67	34.67	33.83	27.58	22.08	30.17	27.25	22.33
14	14.25	8.58	7.67	17.08	34.75	34.67	33.62	27.33	21.75	30.25	27.16	22.00
15	14.00	8.46	7.71	17.42	34.92	34.62	33.46	27.00	21.42	30.33	27.08	21.67
16	13.75	8.33	7.75	17.75	34.83	34.58	33.17	26.66	21.08	30.33	27.00	21.33
17	13.50	8.25	7.75	18.00	34.92	34.54	32.92	26.42	20.83	30.25	27.00	21.00
18	13.25	8.21	7.75	18.17	35.00	34.50	32.67	26.17	20.58	30.33	27.00	20.75
19	13.00	8.17	7.71	18.33	34.83	34.46	32.46	26.00	20.33	30.50	27.00	20.45
20	12.83	8.08	7.67	18.58	34.92	34.42	32.25	26.08	20.08	30.42	26.96	20.17
21	12.67	8.00	7.63	18.75	34.92	34.42	32.08	26.17	19.75	30.33	26.92	19.88
22	12.50	7.92	7.58	18.92	34.79	34.42	31.92	26.17	19.50	30.16	26.83	19.58
23	12.33	7.83	7.67	19.17	34.58	34.42	31.67	26.25	19.25	29.96	26.79	19.33
24	12.17	7.75	7.83	19.42	34.33	34.37	31.50	26.33	19.00	29.75	26.75	19.08
25	12.00	7.75	8.17	20.17	34.00	34.25	31.33	26.42	19.00	29.62	26.71	18.83
26	11.83	7.75	8.50	21.00	33.79	34.17	31.17	26.46	19.17	29.42	26.67	18.58
27	11.63	7.75	9.08	21.75	33.46	34.17	30.92	26.50	19.21	29.25	26.33	18.33
28	11.42	7.71	9.58	22.75	33.08	34.17	30.58	26.50	19.17	29.08	25.83	18.04
29	11.21	7.67	9.92	23.92	33.00	34.17	30.33	26.54	19.25	28.92	25.42	17.83
30	11.00	.....	10.25	25.17	33.08	34.17	30.08	26.54	19.67	28.75	25.00	17.58
31	10.79	.....	10.50	.....	33.17	.....	29.83	26.33	.....	28.62	.....	17.33

HOOSIC RIVER AT BUSKIRK, N. Y.

A gaging station was established at the highway bridge in Buskirk village, September 25, 1903. The gage is read twice each day by Bert C. Henry, from a chain gage attached to the bridge. Hoosic River has its headwaters on the west slope of the Hoosic Mountains in Ver-

[a] See also Report on Stream Gagings, contained in Supplement, Report of State Engineer and Surveyor, 1902, pp. 230 to 234.

mont and Massachusetts. Two head branches, one flowing southward, the other northward along the west slope of this range, join at North Adams, Mass. The stream then flows in a northwestern direction, entering Hudson River 3 miles north of Mechanicsville. The drainage basin above Buskirk is rugged and precipitous, the distribution of tributaries affording rapid concentration of the run-off from the steep rock slopes. The soil is generally firm and tenacious in the valleys. The ridges are sparsely wooded. The general elevation of the valley at the junction of the headwaters is 1,000 feet. Numerous dams, affording power for textile, agricultural-implement, and other industries, are scattered throughout the length of the stream from North Adams to Schaghticoke.[a] There are no important lakes and but one storage reservoir in the drainage basin, this being at Farnam, near the head of the South Branch.

The State boundary to the south of Hoosic River follows the Taconic Ridge, which forms the divide between the Hoosic in Massachusetts and Little Hoosic River in New York.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Drainage areas of Hoosic River.[a]

Location.	Area, place to place.	Total square miles.
Above junction branches, North Adams, Mass	118.8	118.8
Above New York State line	115.6	234.4
Above Hoosic Falls	118.5	352.9
Above mouth Walloomsac River	2.6	355.5
Walloomsac River, above mouth	159.0	514.5
Above Buskirk	64.1	578.6
Above Schaghticoke	56.7	635.3
Above mouth	80.5	715.8

[a] From United States Geological Survey Topographic Atlas, the drainage basin being shown on the Taconic, Mettawee, and Cohoes sheets.

Discharge measurements of Hoosic River at Buskirk, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 2 [b]	C. C. Covert	564	0.79	3.29	446
July 27	do	314	.71	1.60	225
August 26	H. R. Beebe	336	.88	1.75	294
October 6	A. M. Evans	398	1.23	2.11	489
November 10	H. R. Beebe	387	1.23	2.09	475

[a] Water power as it existed in 1880 is described in Tenth Census, 1880, vol. 16, pt. 1, pp. 375-380.
[b] River frozen over below bridge. *Probable backwater.*

Mean daily gage height, in feet, of Hoosic River at Buskirk, N. Y., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	D
1	3.89	2.53	3.79	3.76	4.38	2.46	2.30	1.75	1.49	3.26	2.55	
2	3.86	2.59	3.53	5.26	4.04	2.36	2.42	1.60	1.50	2.88	2.51	
3	3.86	2.43	7.22	4.23	3.68	2.34	2.12	1.88	1.53	2.63	2.41	
4	3.51	2.76	10.78	3.51	3.56	2.24	2.04	1.75	2.03	2.25	2.35	
5	3.76	2.51	8.18	3.51	3.31	2.62	1.96	1.68	1.86	2.11	2.31	
6	3.66	2.49	6.95	3.60	2.88	2.55	1.93	1.65	1.73	2.15	2.25	
7	3.59	2.13	6.75	4.09	2.97	2.63	1.81	1.50	1.58	2.21	2.25	
8	3.69	7.89	14.75	4.27	2.67	3.38	1.83	1.55	1.52	2.25	2.21	
9	3.66	5.41	11.74	5.62	2.80	11.66	1.79	1.62	1.49	2.15	2.08	
10	3.51	4.33	9.44	5.72	2.60	7.18	1.73	1.52	1.62	2.35	2.21	
11	3.51	4.13	8.44	5.07	2.95	4.91	2.09	1.62	1.69	2.61	1.92	
12	3.29	3.89	7.47	4.35	2.77	4.03	1.81	1.92	1.67	2.68	1.95	
13	3.39	3.61	7.09	4.15	2.65	3.65	2.09	1.75	1.59	2.68	1.82	
14	3.29	2.86	6.74	3.85	2.50	3.38	1.96	1.48	1.58	2.55	2.18	
15	3.29	2.91	6.31	3.47	2.40	3.13	1.83	1.72	5.56	2.53	2.15	
16	3.19	3.29	5.54	3.45	3.30	3.93	1.69	1.62	3.81	2.41	2.18	
17	2.96	3.19	4.97	3.25	3.87	2.71	1.56	1.58	2.74	2.41	2.10	
18	2.99	3.06	4.94	3.59	3.20	2.63	1.61	1.52	2.51	2.21	1.98	
19	3.11	3.09	5.11	3.82	3.35	2.51	1.72	1.45	2.06	2.18	1.98	
20	3.06	3.19	6.01	3.47	4.05	2.55	1.68	1.60	2.00	2.18	1.80	
21	3.11	2.76	4.14	3.27	3.37	2.40	1.62	3.00	2.07	3.41	2.45	
22	3.11	6.59	3.21	3.08	3.16	2.40	1.68	2.22	2.00	5.71	2.58	
23	6.96	7.26	6.46	3.06	2.94	2.32	1.60	2.15	1.97	3.98	2.40	
24	3.96	5.29	4.06	3.34	2.72	2.24	1.48	2.08	1.93	3.53	2.35	
25	3.11	4.61	4.28	4.08	2.64	2.14	1.70	1.80	2.00	3.11	2.45	
26	2.86	4.09	8.26	4.14	3.24	2.07	1.60	1.84	2.12	3.11	2.10	
27	2.59	3.91	6.46	4.01	2.84	2.10	1.68	1.74	2.24	3.11	2.10	
28	2.56	3.53	4.48	5.26	2.66	2.04	1.72	1.49	2.06	2.81	2.28	
29	2.66	3.63	3.73	5.01	2.42	2.10	1.95	1.64	2.06	2.71	2.05	
30	2.43	.....	3.48	4.74	2.46	2.07	1.75	1.57	3.99	2.65	2.25	
31	2.46	.....	3.50	.....	2.74	.....	1.50	1.54	.....	2.61	.....	

[a] River frozen near gage at times.

MOHAWK RIVER AT LITTLE FALLS, N. Y.

This gaging station is located at the lower, or Gilbert's dam, Little Falls, N. Y. The dam is of masonry, having the form of a cular arc in plan, and furnishes power for the Astoronga Knitting M and the Little Falls Paper Company's mills. In the Astoronga Ki ting Mill there are installed two turbines, one 43 inches and the ot 54 inches in diameter, built by T. H. Risdon & Co., Mount Holly, N In the Little Falls Paper Company's mill are three Camden turbi and one 60-inch Day turbine, built in Little Falls. There are th dams at Little Falls. The lower two are used for water-power devel ment. The upper one is a State dam, diverting water for the sup of Erie Canal. The gage record as kept at the lower dam shows amount of water flowing downstream from Little Falls, but does include diversion at the State dam above the gaging station, and he does not represent the total yield or inflow from the tributary dra

area of 1,306 square miles. In calculating the discharge for 1903 1904 use has been made of the experiments of the United States logical Survey at Cornell University, 1903, on flow over dams. ie observations at this station during 1904 have been made under direction of R. E. Horton, district hydrographer.

daily discharge, in second-feet, of Mohawk River at Little Falls, N. Y., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
.....	1,869	5,705	13,520	8,025	1,041	675	3,005	1,523	2,045	1,106	1,710	1,440
.....	1,670	6,243	14,130	7,203	2,002	675	3,722	1,270	1,575	1,072	1,429	1,344
.....	2,179	6,419	12,610	5,863	1,067	578	2,582	1,183	1,312	935	1,333	1,346
.....	4,119	6,439	8,943	8,573	1,150	652	1,835	1,479	1,533	1,012	1,294	1,346
.....	5,011	7,145	6,940	7,907	1,154	629	1,525	4,762	1,275	2,042	1,661	1,344
.....	4,451	6,278	5,885	6,218	1,197	573	2,138	4,090	1,488	2,776	2,468	1,043
.....	3,084	6,026	5,940	6,114	1,148	540	2,778	3,340	746	2,424	2,133	1,266
.....	2,473	4,512	7,971	7,866	1,148	629	1,442	2,901	851	2,498	1,608	1,268
.....	2,088	3,406	14,510	7,414	1,078	819	1,346	855	821	10,510	1,529	1,065
.....	1,633	2,949	16,740	8,011	850	1,023	1,140	2,835	821	20,260	1,528	885
.....	1,347	2,836	22,310	7,190	974	970	1,268	2,477	991	17,960	1,346	961
.....	1,388	4,086	20,800	5,921	1,022	2,141	834	5,440	1,221	11,940	1,346	1,265
.....	1,250	5,722	16,260	5,724	1,022	5,462	964	4,166	966	7,133	1,343	1,279
.....	1,552	5,591	11,480	4,372	953	3,816	1,033	2,830	927	5,297	1,343	1,348
.....	1,755	3,812	9,412	3,783	988	2,745	999	2,288	1,140	3,396	1,292	1,348
.....	1,854	3,888	8,609	3,209	816	3,048	1,068	1,039	927	2,536	1,344	1,442
.....	1,773	2,593	8,118	3,209	490	2,326	1,033	1,189	1,044	2,368	3,088	1,346
.....	1,334	2,143	7,636	2,741	910	2,472	921	1,189	1,434	8,225	4,768	1,266
.....	1,427	1,831	7,839	2,432	1,091	2,035	753	1,033	1,562	7,589	4,580	1,227
.....	1,373	2,141	8,761	2,296	988	1,666	867	1,528	1,096	6,487	2,833	1,030
.....	1,555	1,900	11,680	2,422	1,022	7,453	1,349	2,968	1,100	5,215	1,878	2,540
.....	2,217	1,887	13,160	2,041	910	8,297	2,038	1,934	1,066	3,610	1,658	3,282
.....	2,565	2,138	8,833	1,536	877	7,125	3,606	1,309	997	1,451	1,777	3,150
.....	2,135	2,138	18,040	1,354	633	6,874	4,458	1,040	962	2,586	2,087	3,210
.....	1,562	2,039	16,500	1,462	628	5,841	2,776	2,633	962	2,289	2,083	3,117
.....	1,807	1,764	10,330	1,662	605	5,915	2,011	6,129	798	2,039	1,442	2,617
.....	1,708	1,813	7,750	1,578	557	4,992	1,487	4,991	808	1,926	1,033	1,945
.....	1,646	2,316	6,384	1,310	628	2,842	2,044	3,889	857	1,727	1,346	2,136
.....	1,907	.....	6,077	1,192	605	2,881	1,200	2,784	1,031	1,826	1,015	1,446
.....	4,810	.....	5,216	1,074	639	1,772	1,342	1,303	1,138	1,826	1,568	1,489
.....	6,026	.....	8,410	.....	400	.....	1,566	2,361	.....	1,874	.....	1,723
1904.												
.....	1,538	1,771	1,841	8,499	9,601	1,927	1,131	1,072	857	6,888	1,665	1,182
.....	1,428	1,613	1,792	11,200	9,474	1,490	1,784	1,072	820	4,820	1,665	1,103
.....	547	1,442	1,991	9,680	7,859	1,441	1,987	1,072	998	3,079	1,539	991
.....	1,189	1,343	2,787	8,471	7,735	1,090	1,701	820	1,061	2,034	1,539	579
.....	1,189	1,265	3,490	8,172	7,191	2,067	1,091	733	2,097	1,818	1,399	930
.....	1,068	1,265	3,173	8,192	6,737	3,023	2,354	1,604	1,526	1,883	1,134	930
.....	1,268	1,421	3,307	9,347	6,137	3,034	2,194	2,392	1,233	1,878	1,361	930
.....	1,346	4,672	4,970	10,250	4,522	2,171	1,452	1,392	897	1,717	1,442	930
.....	1,346	4,769	5,963	14,480	3,789	6,415	1,078	1,003	936	1,505	1,079	930
.....	1,176	4,597	5,432	15,860	2,581	7,322	996	1,035	1,006	2,115	1,061	866
.....	1,286	4,402	5,825	17,060	2,078	4,621	1,218	933	734	7,257	1,079	440
.....	1,247	4,022	5,639	12,050	2,127	2,760	1,340	758	794	7,430	934	930
.....	1,247	3,731	4,403	9,557	1,660	1,880	1,304	787	794	5,447	1,091	928

Mean daily discharge, in second-feet, of Mohawk River, etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
14	1,331	2,914	3,368	7,580	1,820	2,027	1,177	1,166	858	3,880	1,079	930
15	1,331	2,521	2,897	6,097	1,882	1,396	1,095	850	1,226	2,659	1,081	930
16	1,282	2,402	2,369	4,764	4,658	1,536	923	850	2,036	2,101	1,048	889
17	998	1,955	2,361	4,327	4,290	1,236	956	754	1,217	1,926	1,080	818
18	1,265	1,806	2,187	4,521	2,638	969	996	732	1,082	1,528	979	878
19	1,226	1,707	2,038	4,591	2,084	1,353	1,482	856	1,429	1,485	933	889
20	1,226	1,645	2,071	3,788	2,841	1,068	1,065	2,765	1,138	1,359	820	930
21	1,265	1,418	2,471	3,203	4,476	1,033	856	8,712	2,957	4,454	932	889
22	1,265	1,707	2,827	3,138	2,922	1,115	732	6,741	2,602	8,633	1,106	980
23	1,525	2,508	4,909	3,589	2,144	1,191	682	7,162	1,667	6,866	1,002	1,001
24	2,523	2,939	3,365	4,288	1,983	1,395	1,040	5,905	1,768	4,937	1,142	1,418
25	2,937	2,706	10,870	7,568	1,968	980	990	3,875	4,042	3,263	1,182	996
26	2,649	2,409	24,220	10,070	2,227	1,370	1,131	2,238	7,310	2,690	1,070	954
27	2,521	2,229	22,110	8,227	3,320	993	1,337	1,489	4,613	2,696	819	1,480
28	2,353	1,842	16,360	10,480	4,208	823	1,346	1,235	2,948	2,696	1,069	6,340
29	2,080	1,930	10,970	10,790	4,397	794	2,530	1,063	2,151	2,530	1,069	5,068
30	1,982	.....	8,966	10,160	2,127	693	2,398	1,072	7,449	2,161	1,069	4,959
31	1,626	.....	8,359	.....	2,130	.....	1,271	890	.....	1,819	.....	4,866

Estimated monthly discharge of Mohawk River at Little Falls, N. Y., for 1903 and 1904.

[Drainage area, 1,306 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
January	6,026	1,250	2,309	1.77	2.04
February	7,145	1,764	3,777	2.89	3.01
March	22,310	5,216	10,980	8.41	9.70
April	8,573	1,074	4,323	3.31	3.70
May	2,002	400	922	.706	.814
June	8,297	540	2,912	2.23	2.49
July	4,458	753	1,778	1.36	1.57
August	6,129	855	2,541	1.95	2.25
September	2,045	746	1,116	.855	.955
October	20,260	935	4,643	3.56	4.10
November	4,768	1,015	1,862	1.43	1.60
December	3,282	885	1,662	1.27	1.46
The year	22,310	400	3,235	2.48	33.69

Estimated monthly discharge of Mohawk River at Little Falls, N. Y., etc.—Continued.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1904.					
January	2,937	547	1,525	1.17	1.35
February	4,769	1,265	2,447	1.87	2.02
March	24,220	1,792	5,914	4.53	5.22
April	17,060	3,138	8,336	6.38	7.12
May	9,601	1,660	3,987	3.05	3.52
June	7,322	693	1,972	1.51	1.69
July	2,530	682	1,343	1.03	1.19
August	8,712	732	2,033	1.56	1.80
September	7,449	734	2,009	1.54	1.72
October	8,633	1,359	3,405	2.61	3.01
November	1,665	819	1,150	.881	.983
December	6,340	440	1,511	1.16	1.34
The year	24,220	440	2,969	2.27	30.96

MOHAWK RIVER AT DUNSBACH FERRY BRIDGE, N. Y.

This gaging record is kept at the dam of the West Troy Water Company, one-fifth mile above Dunsbach Ferry Bridge, 9 miles from the mouth of the river. The dam is in two sections, situated on opposite sides of a Hudson River shale island. The left wing at the upper end of the island has a crest length of 380 feet. The right wing, 500 feet downstream at the foot of the island, has a crest 280 feet long. The record was established March 12, 1898, for the primary purpose of checking a system of levels for the United States Board of Engineers on Deep Waterways, by D. J. Howell, civil engineer, who has furnished the earlier portion of the record. No record was kept from April 1, 1899, to August 1, 1900. In the pumping station adjoining the dam are two turbines of the old American type, one 66 inches and the other 75 inches in diameter. A new 54-inch Victor turbine was installed during 1902. The discharge is calculated from the recorded daily run of the water wheels and working head. The turbines drive pumps taking water from the river for water-supply purposes at the rate of 1,500,000 gallons per day, equivalent to a continuous flow of 2¼ second-feet. The capacity is being increased. The dam is of masonry, with a flat granite crest 5.5 feet wide. It was rebuilt in 1903 and a new profile obtained. The crest gage is attached to the

timber cribbing 50 feet above the lower section of the dam, with its zero mark at elevation 172.00 referred to the United States Deep Waterways datum. Gage readings are taken twice daily, at intervals of about 12 hours, by Robert Wilson. The mean of the two daily readings is used in computing the flow. The discharge over the main dam has been calculated by means of the weir formula, using coefficients derived from the United States Geological Survey experiments. During high water the current of the stream through the cross section of the channel leading to the lower dam has a velocity of several feet per second. The head due to this velocity has been added to the observed head as a correction for velocity of approach to the lower dam. The upper dam is situated 450 feet upstream from the crest gage.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Mean daily discharge, in second-feet, of Mohawk River at Dunsbach Ferry Bridge, N. Y., for 1903 and 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[b]	Apr.[b]	May.[b]	June.[b]	July.[b]	Aug.[a]	Sept.[a]	Oct.	Nov.	Dec.
1903.												
1	.....	.....	39,310	27,350	1,950	2,320	7,830	.....	.....	1,520	3,760	2,760
2	.....	.....	29,490	18,850	1,850	2,320	7,440	.....	.....	1,760	3,560	2,760
3	.....	.....	23,630	13,870	1,950	2,320	6,850	.....	.....	1,870	3,430	2,760
4	.....	.....	21,370	18,510	2,450	2,560	6,630	.....	.....	1,980	3,430	2,760
5	.....	.....	16,490	13,550	2,150	2,700	3,350	.....	.....	2,600	3,100	2,760
6	.....	.....	15,510	13,270	2,090	2,900	2,650	.....	.....	2,930	3,680	2,760
7	.....	.....	16,830	11,770	2,150	2,940	2,870	.....	.....	3,760	4,540	2,760
8	.....	.....	21,750	23,170	2,028	3,080	3,350	.....	.....	6,680	3,900	2,760
9	.....	.....	39,310	24,430	2,029	2,970	3,918	.....	.....	29,990	3,350	2,430
10	.....	.....	36,150	18,850	2,030	3,230	3,440	.....	.....	[c]84,880	2,990	2,430
11	.....	.....	50,790	12,370	1,910	4,490	3,440	.....	.....	43,210	3,020	2,100
12	.....	.....	46,670	12,050	1,810	8,850	5,580	.....	.....	30,770	3,350	2,100
13	.....	.....	39,310	9,850	1,810	13,030	5,380	.....	.....	21,310	3,300	1,860
14	.....	.....	35,190	6,350	1,750	12,710	4,690	.....	.....	13,730	2,910	2,600
15	.....	.....	29,490	6,810	1,750	11,550	4,980	.....	.....	8,440	3,020	3,[illegible]
16	.....	.....	27,370	7,310	1,660	11,550	4,920	.....	.....	7,680	3,020	3,[illegible]
17	.....	.....	19,950	8,810	1,660	9,890	5,070	.....	.....	6,680	4,380	3,[illegible]
18	.....	.....	18,850	7,310	1,580	7,590	5,008	.....	.....	9,280	12,170	3,[illegible]
19	.....	.....	17,830	5,890	1,580	8,180	4,890	.....	.....	14,690	11,240	3,[illegible]
20	.....	.....	18,150	5,670	1,620	11,400	5,160	.....	.....	13,110	7,920	6,[illegible]
21	.....	.....	19,950	5,388	1,620	19,950	5,490	.....	.....	11,240	6,170	9,[illegible]
22	.....	.....	22,890	5,188	1,620	29,050	6,850	.....	.....	9,280	4,360	11,[illegible]
23	.....	.....	31,250	5,188	1,470	22,510	18,850	.....	.....	6,930	3,650	8,
24	.....	.....	35,190	4,830	1,310	22,890	14,230	.....	.....	6,170	4,060	7,
25	.....	.....	52,950	3,330	1,200	23,630	12,430	.....	.....	5,920	3,840	6,
26	.....	.....	32,590	3,210	1,200	23,630	9,890	.....	.....	5,270	3,760	6,
27	.....	.....	21,750	3,070	1,200	13,930	7,590	.....	.....	5,060	3,590	5,
28	.....	.....	24,850	2,450	1,270	10,970	7,110	.....	.....	4,620	2,930	4,
29	.....	.....	14,170	2,090	1,430	9,890	6,630	.....	.....	4,410	2,760	3,
30	.....	.....	12,110	1,950	1,620	7,110	6,630	.....	.....	4,190	2,930	3,
31	.....	.....	19,230	.....	2,120	.....	6,390	.....	.....	4,190	.....	3,

[a] Record not available.
[b] Record approximate, dam in injured condition
[c] Maximum somewhat greater Approximate owing to back water.

Mean daily discharge, in second-feet, of Mohawk River—Continued.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
1	2,760	1,870	3,570	18,870	21,460	3,760	2,460	2,760	2,020	7,940	3,430	2,930
2	2,430	1,640	3,680	30,940	18,870	3,430	2,760	2,430	1,790	11,860	3,430	2,430
3	2,100	1,180	4,000	30,020	16,400	3,100	2,760	2,600	1,560	8,190	3,100	2,090
4	2,100	1,180	4,150	19,610	14,690	3,100	2,430	2,600	1,790	6,680	3,100	1,830
5	2,410	910	10,320	18,130	13,730	3,260	2,760	2,270	2,520	4,620	3,100	1,870
6	2,520	950	8,920	19,240	11,860	3,590	2,740	2,100	2,190	2,930	2,760	1,870
7	2,430	950	7,860	18,870	10,960	4,190	3,090	2,760	2,100	2,760	2,760	1,760
8	2,100	2,100	8,110	24,220	9,560	4,840	2,760	3,260	1,870	2,560	2,600	1,640
9	1,870	12,480	18,790	25,020	8,720	10,400	2,430	3,100	2,100	1,870	2,430	1,640
10	1,870	5,920	15,630	31,400	7,680	18,500	2,430	2,600	2,430	2,760	2,430	1,640
11	2,070	5,060	12,720	30,940	6,930	14,040	2,100	2,100	2,270	4,620	2,430	1,870
12	2,170	4,620	11,160	27,070	5,920	9,280	2,100	1,870	2,100	7,940	2,430	1,980
13	1,720	4,190	10,320	22,250	5,060	5,700	2,600	1,690	1,980	9,280	2,270	2,100
14	1,870	3,430	8,640	16,740	4,190	4,410	2,390	1,610	2,100	7,180	2,270	2,100
15	1,640	2,760	7,600	12,800	4,410	4,190	2,270	1,610	2,270	5,660	2,270	1,980
16	1,870	1,520	6,340	11,860	5,700	3,760	1,840	1,640	2,430	5,050	2,270	1,870
17	1,870	1,180	5,410	10,960	7,430	3,760	2,060	1,520	2,100	3,830	2,270	1,870
18	1,300	1,070	5,190	10,960	6,680	3,260	2,430	1,410	2,270	2,860	2,430	1,870
19	1,180	1,160	4,540	13,110	6,170	2,760	2,590	1,410	2,270	2,760	2,600	1,870
20	1,180	950	5,190	10,680	6,170	2,430	2,890	2,930	1,870	2,760	3,100	1,760
21	1,180	930	5,620	9,000	6,930	2,100	2,270	9,560	2,270	4,110	3,260	1,640
22	1,180	960	7,600	8,440	7,180	2,270	2,080	13,730	2,760	25,980	3,760	2,760
23	1,300	870	10,600	8,720	5,920	2,100	2,060	12,170	3,980	17,420	3,430	2,100
24	1,870	840	22,960	9,000	5,060	2,230	2,100	9,560	2,930	11,550	3,260	2,270
25	5,920	900	25,740	10,680	4,620	2,350	2,100	7,430	3,100	9,000	2,930	2,430
26	3,760	1,760	35,500	17,760	3,980	2,020	2,630	5,700	5,060	6,680	2,760	2,600
27	2,760	1,410	49,470	17,080	4,620	2,020	2,380	4,190	7,180	6,420	2,700	4,620
28	2,430	950	36,790	19,240	5,270	2,020	2,320	3,590	5,920	5,920	2,430	15,030
29	2,100	950	27,290	25,820	4,840	2,010	3,260	2,600	5,270	5,490	2,600	16,740
30	2,100	.....	21,760	22,640	4,410	2,170	2,930	1,750	4,410	5,060	3,100	10,120
31	1,870	.....	19,940	.....	3,760	.....	2,760	2,090	.....	3,590	.....	8,190

[a] Record approximate owing to ice conditions.

Estimated monthly discharge of Mohawk River at Dunsbach Ferry Bridge, N. Y., for 1903 and 1904.

[Drainage area, 3,440 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
January					
February					
March [a]	52,950	12,110	27,430	7.97	9.19
April [a]	27,350	1,950	10,090	2.93	3.27
May [a]	2,450	1,200	1,738	.505	.582
June [a]	29,050	2,320	10,340	3.01	3.36
July [a]	18,850	2,650	6,404	1.86	2.14
August					
September					
October	84,880	1,520	12,070	3.51	4.05
November	12,170	2,760	4,271	1.24	1.38
December	11,860	1,860	4,188	1.22	1.41
1904.					
January	5,920	1,180	2,127	.618	.712
February	12,480	840	2,231	.649	.700
March	49,470	3,570	13,720	3.99	4.60
April	31,400	8,440	18,400	5.35	5.97
May	21,460	3,760	8,038	2.34	2.70
June	18,500	2,010	4,435	1.29	1.44
July	3,090	1,840	2,477	.720	.83[illegible]
August	13,730	1,410	3,763	1.09	1.26
September	7,180	1,560	2,830	.823	.91[illegible]
October	17,420	1,870	6,624	1.93	2.23
November	3,760	2,270	2,790	.811	.90[illegible]
December	16,740	1,640	3,467	1.01	1.16
The year	49,470	840	5,908	1.72	23.42

[a] Record approximate.

January, February, and March, 1904, record only approximate owing to ice conditions.

ORISKANY CREEK NEAR ORISKANY, N. Y.

A gaging station was established at Wood Road Bridge, 1 mile above the village of Oriskany, June 5, 1901. A vertical board scale is read twice daily by C. H. Smith. Discharge measurements are made during low water only by fording the stream a short distance below the

bridge. The gaging station at Wood Road Bridge was discontinued November 30, 1904, and a new gaging station established at Coleman, 1 mile upstream, where a cableway has been erected for use in making current meter measurements during high water. A dam at Reeder's mills, one-fourth mile upstream, affords opportunity for checking the freshet discharge, and also affords some protection against ice which obstructs Oriskany Creek very seriously in winter. Observations at the cable station were begun August 13, 1904, and are taken twice daily by Peter Gambel. The flow of Oriskany Creek is diverted, as a whole or in part, at the State dam below the gaging station during navigation season. The dam affords opportunity to determine the freshet discharge of the stream during the spring period from the time the ice goes out until the opening of the Erie Canal. Oriskany Creek receives the inflow from storage reservoirs at the head of Chenango River.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Oriskany Creek near Oriskany, N. Y., in 1904.

Date.	Hydrographer.	Area.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
September 28	C. C. Covert	81	1.38	0.80	112
October 7	A. M. Evans	89	1.42	.84	126
November 16	H. R. Beebe	77	1.31	.68	101

Mean daily gage height, in feet, of Oriskany Creek at Coleman, N. Y., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.50	0.82	1.02	0.72	17	1.60	0.68	0.82	0.65	0.45
2	.....	.88	.82	1.05	.72	18	1.78	.52	.82	.50	.40
3	.....	.72	.88	1.18	.68	19	1.60	.62	.80	.62	.38
4	.....	.52	.75	1.00	.90	20	2.04	.32	.78	.72	.72
5	.....	.65	.75	.70	.90	21	1.62	.80	2.10	.92	.30
6	.....	.62	.80	.95	.82	22	1.18	.70	1.98	.88	.45
7	.....	.62	.80	.92	.82	23	1.80	.58	1.85	.82	.42
8	.....	.58	.72	.90	.90	24	1.12	.55	1.25	.78	2.25
9	.....	.65	.72	.90	.72	25	1.95	.85	1.15	.88	.45
10	.....	.68	.90	.88	1.00	26	.85	.82	1.15	.68	.72
11	.....	.50	1.15	.85	.30	27	.78	.85	1.20	.70	.....
12	.....	.52	1.05	.60	.35	28	.68	.82	1.18	.78	.....
13	0.85	.58	.98	.75	.42	29	.70	.82	1.00	.82	.....
14	1.40	.52	.98	.78	.40	30	.62	.88	1.00	.78	.....
15	1.75	1.52	.62	.70	.35	31	.60	.....	1.12	.....	.....
16	1.68	.75	.75	.80	.30						

Mean daily gage height, in feet, of Oriskany Creek at Wood Road Bridge, near Oriskany, N. Y., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	4.15	.....	4.65	4.75	2.90	1.95	1.60	1.75	1.60	1.65	1.95
2	4.05	.....	4.20	4.90	2.90	1.85	1.70	1.90	1.65	1.65	1.90
3	3.90	.....	4.80	3.80	2.70	1.90	1.60	1.75	1.85	1.65	2.05
4	3.95	.....	5.45	3.80	2.80	1.80	1.40	1.60	1.70	1.70	1.95
5	4.15	.....	4.90	3.60	2.25	2.10	1.50	1.70	1.50	1.60	1.60
6	4.40	3.90	4.95	3.50	2.55	2.00	1.75	2.20	1.55	2.00	2.05
7	4.10	5.65	5.60	4.20	2.40	1.80	1.60	1.80	1.40	1.75	1.90
8	4.35	7.75	7.30	3.90	2.30	1.70	1.45	1.70	1.50	1.55	1.90
9	4.35	6.15	6.75	4.05	2.25	2.45	1.50	1.75	1.65	1.70	1.85
10	4.35	5.30	6.10	4.15	2.20	2.35	1.60	1.65	1.60	1.90	1.90
11	3.75	4.90	5.30	3.75	2.35	1.95	1.70	1.65	1.40	2.05	2.05
12	3.25	4.70	4.95	3.95	2.10	1.80	1.75	1.65	1.50	2.10	1.65
13	3.65	4.20	4.80	3.35	2.10	1.85	1.65	1.50	1.40	2.00	1.60
14	4.10	4.20	4.90	3.15	2.05	1.75	1.50	1.65	1.40	1.70	1.80
15	4.00	3.70	4.55	3.15	3.35	1.90	1.65	1.75	2.00	1.50	1.50
16	3.90	.....	4.55	3.10	2.80	2.05	1.70	1.75	1.55	1.75	1.70
17	3.95	.....	4.80	3.20	2.30	1.70	1.50	1.50	1.50	1.60	1.80
18	3.70	.....	4.50	3.10	2.20	1.45	2.10	1.70	1.45	1.50	1.70
19	3.90	.....	4.50	3.05	2.30	1.35	1.95	1.60	1.50	1.75	1.55
20	3.70	3.40	5.45	2.90	2.80	1.50	1.55	3.15	1.60	1.65	1.65
21	3.80	3.40	5.85	2.90	2.80	1.80	1.60	2.40	1.60	3.50	1.90
22	3.95	6.40	6.30	2.80	1.95	1.65	1.55	1.95	1.65	2.65	1.85
23	5.20	5.00	7.95	2.80	1.75	1.65	2.40	2.55	1.35	2.35	1.75
24	5.10	5.00	7.50	2.60	2.05	1.55	1.80	1.90	1.75	1.95	1.70
25	4.75	4.40	7.65	2.80	1.90	1.55	1.80	1.80	1.85	1.75	1.80
26	4.55	4.05	7.30	2.60	2.00	1.45	2.10	1.85	1.75	1.90	1.90
27	4.45	3.65	5.50	2.65	2.15	1.55	1.85	1.70	1.65	1.85	1.80
28	4.45	4.15	4.00	3.40	1.90	1.55	1.95	1.55	1.70	2.05	1.90
29	4.30	5.15	3.65	3.30	1.95	1.70	2.45	1.50	1.65	2.00	2.20
30	4.30	.....	3.70	3.10	2.10	1.75	2.00	1.65	2.35	1.90	2.50
31	4.10	.....	3.70	.....	2.30	.....	1.80	1.55	.....	2.00	.....

[a] Ice conditions January 1 to March 25.

Mean daily discharge, in second-feet, of Oriskany Creek at State dam, near Oriskany, N. Y., for 1904.

Day.	Mar.	Apr.	Day.	Mar.	Apr.	Day.	Mar.	Apr.	Day.	Mar.	Apr.
1	.....	1,250	9	.....	765	17	.....	420	25	2,710	280
2	.....	1,140	10	.....	1,190	18	.....	420	26	3,855	280
3	.....	635	11	.....	730	19	.....	385	27	1,542	280
4	.....	550	12	.....	550	20	.....	350	28	780	280
5	.....	635	13	.....	550	21	.....	330	29	590	280
6	.....	875	14	.....	510	22	.....	280	30	925	280
7	.....	825	15	.....	350	23	.....	280	31	875	.....
8	.....	765	16	.....	350	24	.....	1,340	280		

Estimated monthly discharge of Oriskany Creek near Oriskany, N. Y., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
ırch 25–31	3,855	590	1,577
ril	1,250	280	536

STARCH FACTORY CREEK NEAR NEW HARTFORD, N. Y.

A gaging weir was erected on this stream above the head of the mer Savage reservoir May 26, 1903. The stream flows in a gulf) feet below the general plateau. The weir has a horizontal iron st 6 feet in length with end contractions. The weir gage is placed eet upstream from the weir and is observed twice daily. The dis- ırge is calculated by the Francis formula. In extreme freshets, : discharge is observed at a masonry intake dam a short distance wnstream. The drainage basin of Starch Factory Creek includes aefenberg Creek and reservoir, as elsewhere described. Graefen- ;g reservoir has a capacity of 30,000,000 gallons, and water is 'erted therefrom through a 12-inch conduit.

The region tributary to Starch Factory Creek consists of cleared m land, chiefly sodded slopes rising from the stream to the divide either side, a height of 300 to 400 feet, in a distance of about 1 mile ɔm the main stream. A limited number of lateral tributaries drain : more remote portions of the area. The stream is tributary to Mo- wk River near Utica, N. Y. The drainage basin is shown on the ica sheet of the United States Geological Survey Topographic Atlas, ɔm which the drainage areas have been taken.

The observations at this station during 1904 have been made under : direction of R. E. Horton, district hydrographer.

Drainage areas of Starch Factory Creek.

	Sq. miles.
ove Graefenberg reservoir dam [a]	0.45
ove gaging weir	3.40
ove Savage reservoir dam	3.81
ove mouth	6.60

[a] Topographic area above Graefenberg reservoir dam. The yield is developed from this area by ling from springs.

Mean daily discharge, in second-feet, of Starch Factory Creek near New Hartford, N. Y. for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	De
1	1.59	1.00	1.22	[a] 87.00	5.24	1.34	2.02	1.63	0.61	0.71	1.18	1
2	1.47	1.00	1.28	[b] 43.75	3.31	1.18	1.34	4.76	.56	.66	1.08	
3	1.47	.90	8.00	[b] 15.35	2.28	1.18	1.21	1.45	.48	.56	1.02	
4	1.47	.79	25.12	[b] 8.10	2.15	5.92	1.12	1.18	.65	.56	.96	
5	1.47	.79	3.20	[b] 7.05	2.02	2.28	1.75	.93	.56	.56	.96	
6	1.41	1.28	2.22	[b] 21.16	1.81	1.94	1.51	1.06	.48	.66	.96	
7	1.84	69.88	8.03	[b] 27.50	1.69	1.21	1.18	.80	.48	.71	.96	
8	1.34	33.00	48.45	[b] 15.60	1.63	1.18	1.06	.74	.48	.56	.91	
9	1.34	14.00	9.70	[b] 28.00	1.57	14.09	.87	.74	.48	.61	.86	
10	1.22	13.50	5.33	21.80	1.45	6.12	1.63	.74	.48	1.62	.91	
11	1.22	10.80	3.99	16.80	1.45	2.98	2.15	.74	.48	2.67	.86	
12	1.34	7.89	3.29	17.70	1.34	1.75	2.98	.74	.48	1.49	.86	
13	1.22	4.94	2.40	7.50	1.15	1.21	2.02	.74	.48	1.08	.86	
14	1.22	4.00	2.03	4.80	1.12	1.18	1.21	.93	.48	.96	.86	
15	1.22	2.03	1.90	5.00	10.83	1.27	1.12	.68	1.81	.86	.81	
16	1.22	1.53	1.90	4.70	5.54	2.10	1.00	.68	.81	.86	.86	
17	1.22	1.72	1.90	8.22	2.82	1.45	1.00	.62	.56	.66	.71	
18	1.10	1.34	1.78	9.20	1.94	1.27	2.10	.68	.56	.66	.61	
19	1.05	1.28	3.73	5.82	1.75	1.21	1.06	.59	.61	.66	.61	
20	1.00	1.16	4.27	4.40	2.42	1.12	.87	12.24	.61	.66	.86	
21	.95	1.34	2.88	3.65	2.28	1.18	.87	2.58	.61	31.38	1.19	
22	1.10	3.73	6.86	6.32	1.69	1.18	.80	14.72	.56	4.97	1.08	
23	2.09	2.22	[b] 62.00	13.70	1.33	1.18	8.70	4.01	.56	2.90	.96	
24	1.90	1.72	[b] 46.00	7.48	1.94	1.18	1.51	2.02	1.02	1.95	.91	
25	1.59	1.41	250.00	9.54	1.33	1.00	1.06	1.45	1.13	1.68	1.02	
26	1.34	1.41	[a] 221.50	5.34	2.98	2.10	6.32	([c])	1.53	1.81	.96	
27	1.22	1.16	[a] 40.00	10.24	2.74	2.10	1.88	([c])	.86	2.08	.91	2
28	1.10	1.16	[a] 19.50	16.45	1.57	2.10	2.74	([c])	.66	1.74	.86	2
29	1.05	1.22	[a] 17.50	7.58	1.27	1.45	6.02	([c])	1.81	1.68	.86	
30	1.00	.....	[a] 21.00	6.90	1.39	1.57	1.94	([c])	1.36	1.55	.96	
31	1.00	.....	[a] 26.00	.....	1.69	.....	1.39	([c])	.....	1.24	.....	

[a] 50-foot spillway. [b] Approximate. [c] Repairing weir.

Estimated monthly discharge of Starch Factory Creek near New Hartford, N. Y., for 1904.

[Drainage area, 3.40 square miles.]

Month.	Discharge in second-feet.			Corrected mean.[a]	Run-off.		Rainfall.
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.	Inches.
January	2.09	0.95	1.30	2.07	0.609	0.702	1.69
February	69.88	.79	6.49	7.26	2.14	2.31	1.79
March	250.00	1.22	27.51	28.27	8.45	9.74	2.91
April	87.00	3.65	14.89	15.67	4.61	5.14	3.53
May	10.83	1.12	2.38	3.15	.926	1.07	3.61
June	14.09	1.12	2.23	3.00	.882	.984	4.82
July	6.32	.80	2.01	2.78	.818	.943	6.94
August 1-25	14.72	.59	2.30	3.07	.903	.840	4.34
September	1.81	.48	.74	1.51	.444	.496	2.79
October	31.38	.56	2.28	3.05	.897	1.03	3.11
November	1.19	.61	.91	1.68	.494	.551	.60
December	26.20	.56	2.85	3.62	1.06	1.22	2.80

[a] Including diversion to Graefenberg reservoir.

SYLVAN GLEN CREEK NEAR NEW HARTFORD, N. Y.

New Hartford, or Sylvan Glen, Creek is the inflowing stream tributary to reservoir No. 4 of the Utica waterworks. The stream consists of two main branches, the larger flowing in a deep-cut wooded shale valley, the smaller draining a shallow ravine and a marshy divide. The flow of this stream became very small in May, 1900, and it may become dry at times. The weir, which is located at the mouth of the stream, was erected in January, 1904, by the Consolidated Water Company, of Utica, N. Y., by whom the record is furnished. The gage is placed 6 feet upstream and is read twice daily. The weir has a central low-water notch 2 inches deep and 2 feet long, and a main crest 8 feet long with two end contractions. The drainage basin, which lies at an elevation of from 700 to 1,500 feet above tide, is shown on the Utica and Oriskany sheets of the United States Geological Survey Topographic Atlas. It comprises chiefly woodland and pasture with some tillage, 1.18 square miles in extent.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Mean daily discharge, in second-feet, of Sylvan Glen Creek at New Hartford, N. Y., f 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	De
1	.....	0.15	0.20	11.65	1.38	0.31	0.26	0.64	0.10	0.16	0.34	0
2	.....	.15	.21	4.21	.88	.23	.64	.60	.10	.13	.31	
3	.....	.15	1.17	1.83	.77	.23	.31	.47	.13	.12	.31	
4	.....	.14	2.27	1.90	.60	3.29	.12	.26	.12	.12	.29	
5	.....	.14	.42	2.27	.49	.55	.55	.19	.09	.11	.29	
6	.....	.15	.29	1.90	.41	.73	.36	.27	.09	.12	.26	
7	0.22	3.23	1.51	6.65	.38	.34	.17	.20	.08	.11	.25	
8	.22	9.61	9.53	4.06	.31	.27	.12	.16	.10	.09	.25	
9	.22	4.41	3.19	5.41	.27	6.15	.09	.13	.10	.11	.23	
10	.22	1.61	.96	4.80	.23	1.75	.29	.15	.09	.40	.23	
11	.22	.62	.62	3.75	.19	.73	13.94	.16	.08	.73	.20	
12	.20	.36	.39	3.85	.17	.47	5.16	.13	.08	.45	.21	
13	.21	.27	.32	1.68	.16	.32	1.31	.13	.07	.34	.20	
14	.20	.27	.27	1.15	.13	.25	.49	.17	.09	.26	.23	
15	.20	.25	.25	1.09	3.56	7.90	.32	.12	.41	.21	.21	
16	.20	.21	.22	1.38	1.15	1.09	5.16	.08	.15	.20	.21	
17	.20	.18	.22	3.65	.60	.47	.17	.08	.10	.16	.17	
18	.15	.15	.22	3.26	.36	.32	.47	.10	.08	.13	.13	
19	.15	.12	.24	1.98	.41	.25	.19	.09	.10	.12	.16	
20	.14	.11	.62	1.20	1.26	.17	.11	4.06	.13	.11	.23	
21	.14	.10	.37	1.90	.60	.21	.10	.99	.11	16.01	.27	
22	.15	.42	1.26	1.38	.40	.32	.10	4.06	.09	1.46	.23	
23	.44	.29	15.12	1.09	.25	.19	3.75	1.53	.08	.82	.21	
24	.32	.26	9.23	.93	.27	.13	.64	.51	.36	.64	.19	
25	.26	.21	39.61	1.09	.21	.11	.38	.36	.34	.55	.27	
26	.22	.20	27.59	.93	1.46	.09	3.85	.26	.38	.64	.21	
27	.22	.15	2.72	1.46	1.15	.07	.77	.19	.26	.73	.16	
28	.20	.15	1.10	3.96	.43	.07	.99	.15	.17	.60	.16	
29	.15	.22	1.10	1.98	.32	.13	2.21	.12	.38	.43	.15	
30	.15	.....	2.56	1.75	.68	.38	.73	.11	.36	.38	.10	
31	.15	.....	1.68	.....	.49	.....	.47	.10	.....	.36	.....	

Estimated monthly discharge of Sylvan Glen Creek near New Hartford, N. Y., for 1904.

[Drainage area, 1.18 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January 7-31	0.44	0.14	[a] 0.21	0.178	0.205
February	9.61	.10	.84	.712	.768
March	39.61	.20	4.05	3.43	3.95
April	11.65	.93	2.80	2.37	2.64
May	3.56	.13	.64	.542	.625
June	7.90	.07	.92	.780	.870
July	13.94	.09	1.43	1.21	1.40
August	4.06	.08	.53	.449	.518
September	.41	.07	.16	.136	.152
October	16.01	.09	.86	.729	.841
November	.34	.10	.22	.186	.208
December	22.07	.09	1.35	1.14	1.31
The year			1.17	.988	13.49

[a] Mean for 25 days taken as mean for entire month.

GRAEFENBERG CREEK NEAR NEW HARTFORD, N. Y.

A gaging weir was erected above the inflow to Graefenberg reservoir, June 7, 1903, and a standard rain gage was placed on the adjoining meadow slope some distance from trees and structures. This small catchment basin, having a topographic area, 0.282 square mile in extent, is cleared farm land, chiefly meadow and pasture.[a] It lies between elevations 1,100 and 1,300 feet above tide, and near the summit of the general plateau south of Mohawk River. The soil is porous and the stream is fed largely from the ground water reserve.[b] The weir is compound in form, 5 feet crest length with two end contractions and a central notch 2 feet long .21 foot deeper.

The discharge is calculated by the Francis formula. The gages are read by R. O. Salisbury, and the record furnished by the Consolidated Water Company of Utica, N. Y.

[a] Yield from this area developed by tiling from springs in surrounding slopes.

[b] Other nearby stream channels have tributary areas of equal or larger extent run dry in summer.

Precipitation, in inches, at Graefenberg reservoir, near New Hartford, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.01	.....	0.36	0.34	.....	0.03	0.745	0.15	T.	T.	.....	.....
2	T.	T.	.....	.35	.....	.....	.19	.02	T.	0.02	T.	.....
3	.41	0.04	T.	.50	.....	T.	.195	.17	T.	.03	.....	.....
4	.04	.03	.10	.....	.....	.....	.....	.....	0.19	.....	.....	0.04
5	.....	.01	.....	.....	.....	.90	.09	.....	.....	.....	T.	T.
6	T.	.31	.....	.....	.....	.225	.39	.135	.....	.18	0.04	.04
7	.....	T.	T.	.....	.....	.01	T.	.....	.....	T.	T.	T.
8	.....	.57	.73	.....	.....	.....	T.	.....	.....	.....	.....	.02
9	.05	T.	T.	.03	T.	1.18	.....	T.	.02	.04	.....	.03
10	.09	.....	.04	.23	T.	.29	.31	.....	T.	.22	.....	.....
11	.01	.....	.....	.17	.....	.....	.365	.08	.....	.31	.....	.....
12	(a)	.....	.....	.24	.....	.....	1.08	.04	.....	.04	.....	.....
13	.....	.....	T.	.05	.....	.....	.19	.01	T.	.13	.03	.05
14	.....	T.	T.	T.	.....	.....	.....	.23	.....	.....	.....	T.
15	.....	.....	.12	.03	0.78	.13	.....	.....	.76	.....	.....	T.
16	.....	.10	.02	.52	.75	.81	.015	.....	.01	.....	.....	.....
17	.....	.01	.....	.....	.....	.....	.....	.....	.....	.....	.....	T.
18	.....	.....	.08	.....	.....	.....	.41	.13	.....	.....	.....	.02
19	.....	.....	.21	.....	T.	.....	.....	.....	.02	.....	.....	.02
20	.....	.03	T.	.06	.34	.....	.....	1.19	.....	.....	.....	.02
21	.....	.....	T.	.02	.80	.14	.005	.....	.19	.76	.10	.12
22	.....	T.	.08	.....	T.	.01	.....	.....	T.	.70	.....	T.
23	.....	.05	.....	.....	T.	.17	.745	1.04	.....	T.	.....	.05
24	.....	.11	.....	.....	.24	.....	.30	.....	.25	T.	.....	.14
25	.....	.03	.....	.11	.....	T.	T.	.....	.24	T.	.16	.....
26	.....	T.	.....	.005	.32	.....	.615	.01	T.	.08	.02	.01
27	.09	.....	.18	.02	.23	.....	.065	.....	.26	.11	T.	.60
28	.....	.....	.14	.69	.10	.....	.26	.....	.....	T.	.09	1.33
29	.....	.20	.....	.07	.....	.38	.77	.....	T.	.....	.03	.07
30	.01	.....	.....	.07	.....	.01	.....	.....	.36	.....	.....	.....
31	.....	.....	.....	.....	.35	.....	.....	.....	.....	.....	.....	.....
Total	.71	1.49	2.06	3.505	3.91	4.28	6.74	3.20	2.30	2.62	.47	2.56

a No record January 12-25, 1904.

Precipitation, in inches, at Savage reservoir, near Utica, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	0.96	0.29	0.07	0.02	0.53	0.35	.....	.....	.....	.....
2	.....	0.05	.....	.52	.....	.....	.23	.03	.....	0.07	.....	.....
3	0.42	.07	.....	.09	.....	.....	.....	.78	.....	.03	.....	.....
4	.06	.24	.11	.....	.....	.72	.01	.....	0.35	.....	.....	.....
5	.....	.....	.....	.....	.....	.07	.70	.....	.03	.....	0.06	.....
6	.....	.....	.....	.....	.....	.23	.....	.39	.....	.21	.....	0.08
7	.....	.76	.64	.27	.....	.05	.....	.....	.....	.....	.....	.....
8	.06	.10	.....	.....	.....	.07	.....	.....	.....	.....	.....	.05
9	.10	.09	.....	.10	.....	1.42	.....	.....	.07	.07	.....	.07
0	.....	.03	.....	.23	.....	.31	.43	.....	.....	.26	.....	.....
1	.....	.....	.11	.21	.....	.....	.21	.09	.....	.41	.....	.....
2	.....	.....	.....	.16	.....	.....	1.02	.04	.....	.05	.....	.....
3	.....	.....	.....	.13	.....	.....	.36	.01	.....	.16	.....	.14
4	.34	.....	.....	.....	.....	.....	.....	.34	.....	.....	.11	.04
5	.....	.09	.19	.07	1.54	1.04	.01	.....	.84	.....	.....	.....
6	.20	.04	.06	.37	.12	.03	.....	.....	.06	.....	.....	.....
7	.....	.13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	.....	.....	.38	.....	.....	.....	.45	.27	.....	.....	.....	.06
9	.10	.....	.....	.....	.10	.....	.....	.....	.16	.....	.....	.04
0	.18	.....	.....	.....	.31	.....	.....	1.37	.....	.....	.....	.06
1	.....	.....	.....	.19	.19	.10	.02	.76	.21	1.10	.09	.17
2	.99	.10	.07	.....	.....	.26	.....	.....	.....	.95	.....	.....
3	.....	.18	.61	.....	.06	.....	1.14	1.04	.....	.02	.....	.08
4	.....	.17	.....	.14	.33	.....	.01	.....	.46	.03	.....	.17
5	.07	.04	.05	.....	.02	.....	.....	.....	.35	.....	.21	.....
6	.....	.....	.23	.....	.61	.....	.71	.02	.....	.10	.03	.....
7	.05	.....	.....	.09	.26	.....	.14	.....	.32	.15	.06	.60
8	.....	.....	.....	.61	.....	.02	.25	.....	.....	.....	.12	1.32
9	.11	.....	.....	.....	.42	.40	.92	.....	.....	.....	.05	.09
0	.....	.....	.....	.12	.....	.63	.....	.....	.43	.....	.....	.06
1	.....	.....	.35	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	2.68	2.09	3.76	3.59	4.03	5.37	7.14	5.49	3.28	3.61	.73	3.03

REELS CREEK AND JOHNSTON BROOK NEAR DEERFIELD, N. Y.

A gaging record at the waterworks intake dam on Reels Creek was begun January 1, 1901.[a] In order to secure a more accurate record during periods of diversion, a weir was constructed on the shale rock stream bed just above the intake dam in 1903. A second weir was constructed on Johnston Brook, a tributary of Reels Creek, which enters below the point of gaging the latter. The calculated flow and the precipitation observed from a standard rain gage at Deerfield reservoir are given below.

The drainage of Reels Creek lies on the north slope of Mohawk River, to which the stream is tributary. The tributaries are numerous and the valleys deep cut with gravel or sodded slopes favoring rapid discharge of storm waters.

Johnston Brook flows in a deep valley whose tributaries are, lying

[a] See Water-Supply Paper No. 82, p. 82, and Water-Supply Paper No. 97, p. 209; see also Report on Stream Gaugings, contained in Supplement, Report of State Engineer and Surveyor, New York, for 1902, pp. 136–141, also 1903, pp. 94–98.

mostly to the north of the stream, drained by short parallel feeders that head well below the divide and are supplied to some extent from ground storage.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Drainage areas of Reels Creek. [a]

Location.	Square miles.	
	Place to place.	Total.
Reels Creek above weir	4.42	4.42
Reels Creek above Johnston Brook	.05	4.47
Johnston Brook above weir	.78	.78
Johnston Brook above mouth	.01	.79
Reels Creek including Johnston Brook	.79	5.26
Reels Creek above mouth	4.14	9.4

[a] From the Utica sheet of the United States Geological Survey Topographic Atlas.

Mean daily discharge, in second-feet, of Reels Creek near Deerfield, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.68	3.52	2.49	30.50	23.50	.....	0.54	0.17	0.17	1.70	2.98	0.
2	2.42	3.21	2.75	44.80	6.80	.....	1.91	.79	.17	.54	2.78	.
3	2.23	2.90	4.21	30.50	3.40	.....	1.10	.24	.17	.31	2.18	.
4	2.23	2.68	19.62	30.50	2.40	.....	.50	.17	.45	.31	2.04	.
5	2.23	2.49	28.50	30.50	2.40	17.80	1.10	.28	.21	.31	2.04	.
6	2.16	2.98	61.85	32.80	2.40	33.90	1.38	.17	.17	1.38	1.91	.
7	2.10	13.41	99.20	82.00	2.40	6.00	.74	.17	.17	1.04	1.50	.
8	2.10	9.75	65.00	50.10	2.40	3.40	.34	.17	.17	1.04	1.38	.
9	2.10	.....	9.10	41.80	1.80	38.70	.31	.17	.17	1.04	1.32	.
10	2.10	.....	8.35	49.10	1.80	10.50	1.10	.17	.17	1.38	1.27	.
11	2.10	8.94	9.00	76.00	1.80	9.00	.64	.17	.17	1.77	1.22	.
12	2.10	7.70	9.00	115.20	1.80	.....	.74	.17	.17	3.58	1.16	.
13	2.10	6.17	9.00	30.50	1.80	.....	.54	.17	.17	3.82	1.16	.
14	2.10	4.57	9.00	45.10	1.80	.....	.31	.17	.17	3.42	1.16	.
15	2.10	3.52	10.50	18.00	30.50	.....	.21	.17	.17	3.25	1.16	.
16	2.10	2.75	7.70	15.30	23.50	.....	.17	.17	.17	2.78	1.16	.
17	2.10	2.49	7.92	14.00	9.00	.....	.17	.17	.17	2.26	1.16	.
18	2.10	2.49	7.81	18.70	2.90	.....	.79	.17	.17	2.04	1.16	.
19	2.10	2.49	8.04	13.60	2.40	.....	.31	.17	1.50	1.50	1.16	.
20	2.10	2.49	10.14	8.30	12.00	30.50	.21	.....	2.41	1.27	1.91	.
21	2.10	2.49	9.64	9.00	5.20	144.10	.17	6.74	1.70	.....	1.77	.
22	5.92	2.49	8.72	10.50	2.40	99.40	.17	3.01	.45	11.78	1.44	.
23	17.80	3.06	24.31	13.60	2.40	.....	7.26	7.26	.17	7.16	1.32	1.
24	8.04	2.90	19.43	10.50	6.80	.45	2.33	2.11	1.10	5.08	1.27	.....
25	5.65	2.55	92.80	12.00	8.30	.38	1.27	.79	2.48	3.74	1.38	.....
26	4.04	2.49	197.00	14.40	22.50	.31	9.22	.24	1.10	4.00	.98	1.9
27	4.04	2.49	175.50	24.50	27.50	.31	1.70	.17	.54	3.82	.79	.....
28	4.04	2.75	49.90	30.50	7.70	.31	.93	.17	.24	3.74	.74	.....
29	3.69	2.62	33.60	19.50	2.90	2.78	1.32	.17	3.92	3.74	.74	.....
30	3.52	.....	30.50	29.50	8.30	1.50	.64	.17	4.36	3.74	.93	.....
31	3.21	.....	35.20	.....	7.70	.....	.31	.17	.....	3.42	.....	.....

Estimated monthly discharge of Reels Creek near Deerfield, N. Y., for 1904.

[Drainage area, 4.5 square miles.]

Month.	Discharge in second-feet.			Run-off.		Rainfall.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Inches.
anuary	17.80	2.10	3.40	0.756	0.872	4.62
'ebruary, 27 days	13.41	2.49	4.01	.891	.895	3.85
larch	197.00	2.49	34.38	7.64	8.81	2.97
pril	115.20	8.30	31.81	7.07	7.89	2.64
Iay	30.50	1.80	7.69	1.71	1.97	4.17
une, 17 days	14.41	.31	23.49	5.22	3.30	6.16
uly	9.22	.17	1.26	.280	.323	4.63
ugust, 30 days	7.26	.17	.83	.184	.205	4.87
eptember	4.36	.17	.78	.173	.193	4.51
)ctober, 30 days	11.78	.31	2.83	.629	.702	3.87
Iovember	2.93	.74	1.44	.320	.357	.27
December, 24 days	1.91	.45	.57	.127	.113	3.36

Mean daily discharge, in second-feet, of Johnston Brook near Deerfield, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.45	0.50	0.87	8.00	3.22	1.00	0.34	0.18	0.18	0.40	0.37	0.21
2	.45	.50	.87	6.06	1.68	.40	1.00	.18	.18	.18	.34	.12
3	.45	.50	1.68	4.42	1.00	.37	.28	.40	.26	.18	.30	.12
4	.45	.50	1.46	2.92	.74	.37	.18	.18	.22	.18	.30	.12
5	.45	.50	1.36	2.71	.64	3.69	.74	.18	.18	.18	.30	.12
6	.45	.64	6.68	4.79	.47	4.02	.57	.30	.18	.24	.28	.12
7	.45	7.12	8.00	12.64	.47	.52	.24	.18	.18	.18	.24	.12
8	.45	2.81	2.84	6.06	.44	.37	.18	.18	.18	.18	.24	.12
9	.45	1.93	1.46	4.42	.42	(a)	.18	.18	.18	.18	.22	.12
0	.45	1.56	1.36	(b)	.40	.92	1.15	.18	.18	1.74	.18	.12
1	.45	1.46	1.36	10.50	.37	.57	.26	.18	.18	2.24	.18	.12
2	.45	1.05	1.36	10.85	.37	.42	.42	.18	.18	2.44	.18	.12
3	.45	.57	1.36	4.70	.37	.37	.26	.18	.18	1.56	.18	.12
4	.50	.52	1.36	3.38	.37	.64	.18	.18	.18	.74	.18	.12
5	.50	.50	1.30	1.68	4.61	1.20	.18	.18	.52	.78	.18	.12
6	.50	.50	1.30	1.68	2.71	.57	.18	.18	.18	.37	.18	.12
7	.50	.50	1.36	2.06	.92	.37	.18	.18	.18	.32	.18	.12
8	.50	.50	1.46	2.84	.69	.37	1.31	.18	.18	.30	.18	.12
9	.50	.50	1.46	1.62	.37	.37	.21	.18	1.87	.30	.18	.12
0	.50	.50	1.87	1.31	2.64	.37	.18	(a)	1.31	.26	.26	.12
1	.50	.50	1.87	1.56	1.10	1.51	.18	4.02	.30	10.28	.25	.12
2	1.05	.50	2.31	1.46	.42	1.51	.18	1.62	.18	2.71	.21	.12
3	4.10	.78	10.86	1.25	.37	.47	3.46	1.93	.18	1.31	.21	.24
4	1.40	.87	3.76	1.15	1.00	.19	.57	.37	.92	.57	.21	2.06
5	.60	.60	(a)	1.41	1.10	.18	.18	.21	1.93	.47	.25	.78
6	.55	.50	(a)	1.31	3.61	.18	2.51	.18	1.31	.57	.24	.30
7	.55	.50	(a)	1.99	2.71	.18	.32	.18	.26	.57	.18	.82
8	.55	.78	(a)	7.67	.42	.18	.22	.18	.18	.57	.13	7.45
9	.55	.92	2.58	3.38	.37	3.07	.18	.18	(a)	.57	.13	2.44
0	.55	.....	3.30	1.87	.82	.50	.18	.18	1.87	.57	.21	1.31
1	.55	.....	2.18	.....	.92	.....	.18	.18	.....	.50	.....	.54

a Discharge exceeds capacity of weir; record not available.
b *Repairing weir; record not available.*

Estimated monthly discharge of Johnston Brook near Deerfield, N. Y., for 1904.

[Drainage area, 0.79 square mile.]

Month.	Discharge in second-feet.			Run-off.		Rainfall.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Inches.
January	4.10	0.45	0.65	0.823	0.949	4.62
February	7.12	.50	.99	1.25	1.34	3.85
March, 27 days	(a)	.87	2.50	3.16	3.17	2.97
April, 29 days	12.64	1.15	4.06	5.14	5.54	2.64
May	4.61	.37	1.15	1.46	1.68	4.19
June, 29 days	(a)	.18	.86	1.09	1.18	6.16
July	3.46	.18	.53	.671	.774	4.63
August, 30 days	(a)	.18	.43	.544	.607	4.87
September, 29 days	(a)	.18	.48	.608	.656	4.51
October	10.28	.18	1.02	1.29	1.49	3.87
November	.37	.13	.22	.278	.310	.27
December	7.45	.12	.60	7.59	.875	3.36

a Discharge exceeds capacity of weir; record not available.

Precipitation, in inches, at Deerfield reservoir, near Deerfield, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		0.02							0.30			
2	0.65	.12					0.75	0.57		0.05		
3			0.60						.32			
4		.06				0.52						0.10
5		.04				.52	.65	.17		.30		
6		.74		0.45								
7		.94	.44									.05
8	.25					2.03			.25			.10
9			.05	.35		.25						
10							.12	.08		.70		
11				.32						.40		
12				.08			.25			.30		
13				.12				.12				.13
14	1.08		.04			.39						
15		.05		.25	1.49	.38			.32			
16	.22				.08							
17												
18			.22	.25			.77		.82			.10
19		.03							.78			.13
20	.02				.68	.51		2.00			0.05	.20
21	.88				.32			1.25		1.75		
22	1.20	.24	.72			.92		.65				
23		.40			.48		1.08					
24		.16							.48			
25					.23					.17	.22	
26	.32		.45		.40		.65	.03	.32	.20		
27				.40								
28		.45		.20			.36					2.10
29		.60		.10		.52			.92			
30				.12	.41	.12						.45
31			.45		.08							
Total	4.62	3.85	2.97	2.64	4.17	6.16	4.63	4.87	4.51	3.87	.27	3.36

NAIL CREEK AT UTICA, N. Y.

The record of the flow of this stream, obtained at a weir at the foot of the water-supply pond of the Globe Woolen Mill, Utica, N. Y., has been furnished by William S. Bacot, civil engineer. The weir consists of eight notches, each 1 foot in length and 1 foot in depth, cut in ⅛-inch steel plates attached to the upstream side of the waste gates of the pond mentioned. The depth of overflow is observed on a vertical enameled iron gage, divided to feet and hundredths, located 9 feet upstream from the weir. Outflow takes place from a still pond. The waste gates to which the weir is attached are practically water-tight. The very slight leakage occurring has been estimated and allowed for, together with water diverted for use in the adjoining mills. Four of the weir notches are placed 2 inches below the remaining four notches. The lower notches take the entire ordinary flow of the stream. The pond above the weir has an area of 1.4 acres, and a slight error may be introduced in the results on windy days by water slopping over the crests of the higher notches.

The effective drainage area at the weir is less than the natural drainage area, owing to diversion to the combined sewer system of the city in the lower portion of the watershed. The drainage area is nearly all heavily sodded land, comprising suburban plats and pasturage. It contains possibly 5 per cent of cultivated area and an equal percentage of hard earth roads and pavements. Perhaps 10 per cent is sparsely timber covered. The entire area is underlaid with slate shale, usually at a depth of from 2 to 5 feet below surface, and the soil is heavy clay, with occasional gravel and loam. The basin comprises an upper and a lower plateau; the main tributaries rise in the steep side slopes of the upper plateau, which are often deeply serrated, forming gulfs from which springs issue, excepting in unusual droughts. The lower plateau is more or less swampy near the margin of the hills. The upper plateau contains a large cemetery, in which are numerous artificial drains, also a number of small ponds. The drainage areas are shown on the Oriskany and Utica sheets of the United States Geological Survey Topographic Atlas. The drainage from the plateau is received on the north in an artificial ditch following the highway and which separates the area tributary to the stream from the urban district. Below the junction of the main branches, the stream flows in the abandoned channel of the Chenango canal, in which one branch of the stream flows from its source. In unusual freshets the artificial channel carrying the north branch of the stream underneath the street for a distance of about 1,000 feet is of insufficient capacity, and the overflow passes directly into the city sewers and is diverted from its natural course.

Drainage areas of Nail Creek.[a]

	Sq. miles.
Natural area above Globe Woolen Mill	4.32
Effective area prior to August 31, 1904	3.66
Effective area after August 31, 1904	3.49
Upland area above 600 contour	1.40

Mean daily discharge, in second-feet, of Nail Creek at Utica, N. Y., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June	July.	Aug.	Sept.	Oct.
1	.....	1.61	1.81	0.60	1.07	17	.....	.....	.....	0.69	.....
2	.....	2.25	1.55	.81	.....	18	.....	1.32	0.69	.....	.....
3	.....	.....	.....	.....	1.10	19	.....	1.14	.99	.88	.....
4	.....	.....	.....	.75	1.03	20	.....	1.14	1.81	.81	.....
5	.....	1.74	.....	.....	1.10	21	.....	1.14	.....	.84	.....
6	.....	1.68	.....	.....	.....	22	.....	1.14	1.68	.81	.....
7	.....	1.32	.....	.92	.....	23	.....	5.54	4.19	.88	.....
8	.....	1.49	.....	.88	.....	24	.....	.....	2.17	1.03	.....
9	.....	1.28	.....	.88	.....	25	.....	1.18	1.74	.....	.....
10	.....	.....	.....	.92	.....	26	.....	4.29	1.61	.88	.....
11	.....	1.68	.....	.92	.....	27	1.32	2.40	1.44	1.07	.....
12	.....	3.52	.....	1.10	.....	28	1.72	1.61	.....	1.10	.....
13	.....	3.15	.....	.78	.....	29	1.61	4.39	.84	1.10	.....
14	.....	1.88	.....	.81	.....	30	1.32	1.95	.....	1.95	.....
15	.....	2.02	1.10	1.68	.....	31	.....	.....	.....	.....	.....
16	.....	1.32	1.14	.81	.....						

Estimated monthly discharge of Nail Creek at Utica, N. Y., for 1904.

[Drainage area preceding August 31, 1904, 3.66; succeeding August 31, 1904, 3.49 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.[a]	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
June, 4 days	.....	.....	1.49	0.407	0.061
July, 25 days	.....	.....	2.09	.571	.531
August, 14 days	.....	.....	1.63	.445	.232
September, 25 days	.....	.....	.96	.276	.257
October, 4 days	.....	.....	1.08	.309	.046

[a] Part of maximum flow diverted.

WEST CANADA CREEK AT TWIN ROCK BRIDGE, N. Y.

A current-meter gaging station was established at Twin Rock Bridge, September 7, 1900, by R. E. Horton. A gage board, divided decimally, is attached to the upstream side of the right-hand abutment, the coping of the abutment over the gage being used as a bench mark.

[a] From the Utica sheet of the United States Geological Survey Topographic Atlas.

ıe bridge is 167.5 feet long between abutments, and consists of two ıans. The bed is of gravel and cobble, and the entire flow passes ıderneath at all stages. In the winter the stream becomes completely e covered, requiring special discharge measurements. The gage is ad twice each day by George Rood, and the record is furnished by ıe Utica Gas and Electric Company. The drainage area is shown on ıe Utica, Little Falls, Remsen, Wilmurt, Old Forge, and Canada Lakes ıeets of the United States Geological Survey Topographic Atlas. here are about fifty small lakes and a few undrained ponds in the atershed of the stream. Most of these are situated near the head-aters and above the gaging station, the largest single water surface eing Honnedaga Lake, 1.4 square miles in extent. There is also a mall amount of controllable storage in reservoirs formed by three ams. Swamps and marshes are numerous in the region of the head-vaters, usually adjoining lakes and tributaries and having an extent ıf one-half square mile or less each. Much of the region above the gaging station is timber covered. There are extensive sand areas in he central and upper drainage basins. The soil of the upper water-ıhed is underlaid by granitic gneiss usually at or near the surface, ıxcepting in alluvial valleys. From a point just above Twin Rock Bridge and extending downstream beyond Trenton Falls the underly-ng geological formation is Trenton limestone.[a]

Compacted snow accumulates in the woodlands in winter, often to a lepth of 3 or 4 feet, and representing an inch of water for each 5 or 6 inches of snow. This melts slowly, feeding the stream in March and April, which months may show a run-off greatly exceeding the pre-ipitation. The drainage area above Twin Rock Bridge is 364 square niles; above Trenton Falls, 375 square miles. During the present ıeason a Frieze self-recording gage has been erected at Trenton Falls lam. Tests by weir to determine the discharging capacity of the ırbines, which are a special Swiss design, have been made by the ɔower company.

The observations at this station during 1904 have been made under he direction of R. E. Horton, district hydrographer.

[a] For geological description of Trenton Falls see paper by C. S. Prosser and E. R. Cumings in leport of New York State Museum, 1895, pp. 619–628.

Discharge measurements of West Canada Creek at Twin Rock Bridge, N. Y., in 19

Date.	Hydrographer.	Area.	Mean velocity.	Gage height.	Disch
		Sq. feet.	*Feet per sec.*	*Feet.*	*Secon*
June 3	C. A. Swancott	547	0.85	2.18	
August 4	do	404	.75	1.30	
August 30	do	394	.67	1.45	
September 19	Horton and Evans	580	1.03	2.48	
October 8	A. M. Evans	575	1.26	2.33	
October 15	do	645	1.77	2.83	
November 21	Weeks and Swancott	455	.86	1.63	

[a] Log jam at center pier. [b] Log jam below section.

Mean daily gage height, in feet, of West Canada Creek at Twin Rock Bridge, N. Y. 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	3.40	2.20	2.60	3.82	7.70	2.35	3.40	2.30	1.00	6.15	2.10
2	3.50	2.10	2.68	4.48	8.95	2.45	3.85	2.00	1.10	3.50	2.40
3	2.00	2.10	2.80	4.45	8.55	2.22	3.70	1.60	1.55	3.45	2.25
4	2.00	2.05	2.88	3.68	8.40	2.00	3.15	1.20	4.00	2.05	2.30
5	2.00	2.12	3.50	3.52	8.60	3.45	3.45	1.00	3.60	2.25	2.20
6	2.00	2.00	3.50	3.48	8.80	3.15	4.35	4.15	3.10	2.45	1.90
7	2.05	2.15	3.45	3.80	8.35	3.00	3.55	2.90	2.55	2.40	1.78
8	.....	3.20	4.35	4.50	8.20	4.40	2.05	2.55	2.15	2.80	1.72
9	2.20	3.80	5.15	7.00	7.20	5.90	2.10	3.10	2.10	2.22	1.80
10	2.30	2.00	4.85	9.00	6.10	8.45	2.00	1.70	2.00	3.50	1.85
11	2.30	3.90	4.45	7.42	4.45	4.45	1.20	1.45	2.15	7.10	1.70
12	1.09	3.60	4.25	5.70	3.40	3.40	1.20	1.45	2.10	7.00	1.60
13	1.07	3.30	3.75	4.88	3.50	3.00	1.50	1.40	3.05	5.40	1.55
14	2.00	3.20	3.50	4.35	3.25	2.25	1.50	1.45	3.45	3.20	1.42
15	1.90	2.95	3.30	3.52	2.60	2.20	1.20	1.55	3.55	2.50	1.45
16	1.80	2.85	3.00	2.85	6.00	2.35	1.50	.80	3.65	2.35	1.60
17	2.05	2.65	2.82	2.80	5.80	2.25	1.50	.80	2.50	2.40	1.60
18	2.02	2.50	2.80	2.95	5.00	2.12	1.40	1.20	2.20	2.85	1.60
19	2.18	2.38	2.75	2.75	4.00	2.00	1.30	1.10	2.40	2.20	1.60
20	2.30	2.40	2.88	2.62	4.25	1.90	1.25	6.50	3.00	2.10	1.60
21	2.32	2.40	2.80	2.45	5.55	1.95	1.00	9.50	4.25	8.35	1.68
22	2.40	2.68	2.85	2.60	4.30	2.12	1.00	7.50	3.40	5.85	1.68
23	2.40	3.40	3.25	3.00	4.18	2.95	.90	6.45	2.75	4.45	1.60
24	2.50	3.58	4.20	3.95	3.15	2.50	.95	5.05	3.30	3.55	1.72
25	2.75	3.35	4.95	7.50	3.55	2.15	1.20	3.05	6.75	3.15	1.30
26	2.25	3.05	6.05	7.32	4.15	2.00	1.55	3.05	5.75	2.30	1.30
27	2.50	3.00	7.80	7.35	4.65	2.15	2.50	2.90	5.15	2.00	1.40
28	2.40	3.00	6.80	7.80	4.70	1.00	2.65	2.50	4.55	2.35	1.40
29	2.35	2.80	5.70	7.85	3.75	2.05	2.55	1.95	3.40	2.50	1.40
30	2.50	.....	4.82	8.05	3.35	2.30	2.50	1.45	7.55	2.35	1.30
31	2.30	.....	4.12	.....	2.35	.....	2.50	1.25	.....	2.20	.....

NOTE.—Ice corrections made to gage heights and ice curve applied January 1 to March November 27 to December 31, 1904.

Daily discharge, in second-feet, of West Canada Creek at Twin Rock Bridge, N. Y., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[ae]	Apr.[e]	May.[c]	June.[c]	July.[c]	Aug.[c]	Sept.[c]	Oct.[c]	Nov.[ac]	Dec.[a]
.....	712	288	424	2,630	4,630	468	856	454	210	2,960	398	248
.....	750	254	450	3,350	6,140	496	1,100	370	224	900	482	248
.....	220	254	492	3,320	5,630	433	1,010	298	289	878	440	242
.....	220	237	520	2,480	5,450	370	746	238	1,180	384	454	214
.....	220	262	750	2,820	5,700	878	878	210	956	440	426	202
.....	220	220	750	2,270	5,950	746	1,420	1,280	724	496	352	202
.....	237	220	731	2,610	5,390	680	928	646	727	482	329	197
.....	(b)	579	1,140	3,380	5,210	1,450	384	529	412	454	320	197
.....	(b)	816	1,550	6,540	4,070	2,700	398	724	398	433	334	192
.....	(b)	509	1,390	9,640	2,900	5,510	370	316	370	900	343	270
.....	(b)	860	1,190	7,150	1,490	1,490	238	273	412	3,960	316	238
.....	(b)	730	1,090	4,810	856	856	238	273	398	3,850	298	334
.....	(b)	617	860	3,810	900	680	280	266	702	2,240	289	384
.....	(b)	579	750	3,210	790	440	280	273	878	768	270	170
.....	(b)	492	670	2,320	544	426	238	289	928	510	273	185
.....	(b)	458	560	1,690	2,800	468	280	190	984	468	298	180
.....	237	390	500	1,650	2,610	440	280	190	510	482	298	180
.....	228	339	490	1,770	1,900	405	266	238	426	629	298	259
.....	280	296	475	1,610	1,180	370	252	224	482	426	298	190
.....	322	305	520	1,500	1,350	352	245	3,320	680	398	298	190
.....	330	305	492	1,360	2,380	361	210	[d]6,860	1,350	5,390	311	200
.....	356	398	[a]509	1,480	1,380	405	210	4,400	856	2,660	311	200
.....	356	655	[e]2,055	1,820	1,300	668	200	3,270	595	1,490	298	210
.....	390	721	3,040	2,760	746	510	205	1,940	812	928	320	224
.....	475	636	3,900	7,260	928	412	238	702	3,580	746	252	343
.....	305	926	5,260	7,010	1,280	370	289	702	2,570	454	252	343
.....	390	904	7,710	7,040	1,680	412	510	646	2,080	370	256	384
.....	356	904	6,260	7,710	1,670	210	561	510	1,560	468	256	384
.....	339	492	4,810	7,790	1,040	384	527	361	856	510	256	426
.....	390	.....	3,750	8,090	884	454	510	273	4,460	468	242	595
.....	322	.....	2,960	.....	468	.....	510	245	.....	426	.....	790

[a] January 1 to March 22, and November 27 to December 31, from ice curve.
[b] Record not available.
[c] May 1 to November 26 from curve for obstructed channel.
[d] Estimated; above curve.
[e] March 23 to April 30, inclusive, from curve for unobstructed channel.

Estimated monthly discharge of West Canada Creek at Twin Rock Bridge, N. Y., fo

[Drainage area, 364 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	De in
January, 22 days	750	220	348	0.956	
February	926	220	505	1.39	
March	7,710	424	1,808	4.97	
April	9,640	1,360	4,013	11.00	1
May	6,140	468	2,553	7.01	
June	5,510	210	795	2.18	
July	1,420	200	473	1.30	
August	6,860	190	984	2.70	
September	4,460	210	1,019	2.80	
October	5,390	370	1,160	3.19	
November	482	242	319	.876	
December	790	170	278	.764	

EAST CANADA CREEK AT DOLGEVILLE, N. Y.

This creek rises in Hamilton County, flows southward bet Herkimer and Fulton counties, and empties into Mohawk Riv East Creek. A portion of the stream and drainage area is incl on the Little Falls sheet of the United States Geological Survey T graphic Atlas. Observations are taken at High Falls, near Dolge about 7 miles from the outlet of the stream. The gaging stati located at the dam of the Herkimer County Light and Power pany. Readings of the depth on the crest are taken from a ve gage board attached to the bulkhead, 6 feet upstream, twice eac by Willard Hayward. The mean of the readings is used in comp the discharge. A record is also kept of the run of the water w and the elevation of water in the tailrace.

The dam is of rubble masonry 19 feet high and has a flat cr feet in width and 190.25 feet long between abutments. The elev of the upstream edge of the crest is 1 foot below that of the lip. impounded water is conducted to the power house, 500 feet belo dam, through a wrought-iron flume 10 feet in diameter. The re since January 1, 1903, has been computed from a discharge c based on United States Geological Survey experiments on a full- model of the dams made at Cornell University. The flow throug turbines for this period has also been computed from current-n

measurements made in the tailrace of the electric-power plant, instead of from the manufacturers' rating tables for the water wheels, as formerly. The turbines are of a special Victor cylinder gate type; the two main wheels are each 36 inches in diameter and their speed is controlled by Lombard governors. Spruce Creek is the principal tributary of East Canada Creek. It enters East Canada Creek 1 mile above Dolgeville and drains an area of 50 square miles. Water is diverted from this stream at Diamond Hill and from Beaver Creek, one of its tributaries, and is carried to Little Falls through a vitrified conduit 9 miles in length. The water supply of Dolgeville is taken from Cold Brook, a tributary of East Canada Creek. No allowance for diversion for water supply has been made in computing the run-off for East Canada Creek.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Mean daily discharge, in second-feet, of East Canada Creek at Dolgeville, N. Y., for 1903 and 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	669	1,530	3,020	2,510	415	95	1,510	250	736	174	283	98
2	826	1,630	2,320	2,080	394	99	1,220	246	578	182	277	162
3	917	1,130	1,970	2,110	297	80	815	185	457	149	232	219
4	1,210	1,160	1,560	2,590	263	80	662	355	347	97	214	159
5	881	1,640	1,140	1,840	306	100	527	1,250	245	974	196	177
6	939	1,300	1,010	1,500	95	85	561	913	[b] 180	827	405	177
7	752	1,120	991	1,740	257	38	566	938	.....	523	298	151
8	667	865	1,030	2,660	217	112	561	657	229	861	257	129
9	573	641	3,290	2,080	252	199	428	673	123	5,580	262	175
10	583	623	3,200	2,080	[b] 38	422	258	1,020	196	5,970	221	183
11	474	643	7,120	1,760	191	179	182	769	152	3,040	185	201
12	434	1,720	5,530	1,450	191	1,290	175	1,240	124	1,760	196	191
13	516	1,710	4,390	1,280	129	1,740	116	913	([b])	1,220	207	215
14	435	1,440	3,600	1,100	125	1,190	124	716	126	833	196	171
15	414	1,220	3,090	1,030	110	1,050	175	428	149	785	233	216
16	319	886	2,870	988	105	675	248	342	163	633	281	177
17	406	628	2,470	889	[b] 66	605	219	307	112	523	571	202
18	409	591	2,290	788	121	671	190	177	172	1,770	852	175
19	229	485	2,770	741	139	694	296	211	121	1,320	557	199
20	287	583	3,530	696	105	578	363	533	[b] 117	994	587	247
21	338	825	4,690	644	109	1,500	423	461	124	664	455	676
22	1,030	864	4,640	600	109	1,940	440	304	119	625	397	694
23	860	724	5,510	596	109	2,640	661	140	127	546	432	535
24	683	746	6,610	596	[b] 66	3,610	724	159	125	500	384	478
25	595	600	4,130	557	125	1,800	465	740	134	423	371	368
26	851	478	2,720	510	95	1,970	384	2,200	120	381	329	400
27	468	378	2,080	510	101	1,420	390	1,480	[b] 125	364	148	276
28	634	1,040	1,920	447	95	979	263	1,120	134	364	210	238
29	669	.....	1,580	447	95	914	248	954	134	412	163	220
30	1,290	.....	379	415	65	834	390	1,000	123	387	137	236
31	1,300	.....	2,810	.....	[b] 61	.....	316	863	.....	222	.....	238

[a] Approximate. [b] Sunday.

Mean daily discharge, in second-feet, of East Canada Creek at Dolgeville, N. Y., for 19 and 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	De
1904.												
1	170	121	165	1,310	3,870	334	288	188	160	1,590	344	
2	207	135	225	1,510	3,040	297	272	261	160	1,020	314	
3	189	145	235	1,700	3,040	297	221	266	271	731	279	
4	195	133	428	1,430	2,930	267	206	188	418	712	871	
5	194	124	425	1,610	2,590	408	216	150	344	504	647	
6	158	146	415	1,610	2,080	688	221	208	261	450	450	
7	196	189	423	1,860	1,600	616	252	151	225	302	204	
8	171	313	673	2,920	1,300	408	216	144	188	307	245	
9	174	356	808	4,790	1,060	1,420	146	155	176	241	243	
10	229	363	808	5,440	838	1,300	189	188	165	862	223	
11	160	335	761	4,090	766	804	184	133	166	2,380	225	
12	178	311	665	3,120	476	547	166	123	145	1,659	223	
13	185	306	596	2,310	394	413	307	128	150	1,179	251	
14	174	273	492	1,780	352	362	199	21	160	920	276	
15	177	257	359	1,420	579	325	151	128	385	751	215	
16	146	177	341	1,300	999	381	162	128	283	523	223	
17	114	206	364	1,040	843	289	164	122	266	441	156	
18	124	165	291	999	650	242	795	160	126	435	121	
19	132	178	282	920	650	206	325	149	166	419	132	
20	150	183	292	726	847	174	162	3,108	162	412	131	
21	164	183	297	771	775	216	141	2,737	329	4,229	168	
22	188	179	282	722	608	247	136	1,481	183	3,681	162	
23	176	241	626	1,250	519	199	131	1,574	161	1,990	149	
24	129	241	950	2,040	496	151	107	1,039	283	1,298	157	
25	158	215	1,330	3,970	498	141	167	688	809	901	162	
26	160	195	1,910	3,680	498	136	245	576	1,255	773	141	
27	183	212	2,330	3,390	498	141	245	165	867	1,782	136	
28	172	233	2,170	4,470	530	155	266	274	828	646	98	1
29	167	187	1,650	4,100	509	155	736	245	809	494	516	1,
30	160	.....	1,480	4,020	334	221	432	240	1,988	431	150	
31	147	.....	1,440	.....	371	.....	297	175	.....	353	.....	

d monthly discharge of East Canada Creek at Dolgeville, N. Y., for 1903 and 1904.

[Drainage area, 256 square miles.]

Month.	Discharge in second-feet.			Run-off.		Rainfall.[c]
	Maximum.	Minimum.[a]	Mean.	Second-feet per square mile.	Depth in inches.	Inches.
1903.						
.....	1,300	.....	[b]666	2.60	3.00	2.30
y	1,720	.....	[b]971	3.79	3.95	2.38
.....	7,120	.....	[b]3,041	11.88	13.70	6.75
.....	2,660	.....	1,241	4.85	5.41	1.63
.....	415	.....	156	.610	.703	.18
.....	3,610	.....	920	3.59	4.01	8.68
.....	1,510	.....	448	1.75	2.02	5.71
.....	2,200	.....	695	2.71	3.12	7.26
ıer	736	.....	187	.730	.814	1.30
.....	5,970	.....	1,068	4.17	4.81	8.34
er	852	.....	318	1.24	1.38	2.10
er	694	.....	257	1.00	1.15	1.57
he year	.....	.....	.....	.....	44.12	48.20
1904.						
.....	229	.....	169	.660	.761	.....
y	363	.....	217	.848	.915	.....
.....	2,330	.....	758	2.96	3.41	.....
.....	5,440	.....	2,343	9.15	10.21	.....
.....	3,870	.....	1,114	4.35	5.02	.....
.....	1,420	.....	385	1.50	1.67	.....
.....	795	.....	250	.977	1.13	.....
.....	3,103	.....	493	1.93	2.23	.....
ıer	1,988	.....	396	1.55	1.73	.....
.....	4,229	.....	1,046	4.09	4.72	.....
ıer	871	.....	254	.992	1.11	.....
er	1,285	.....	247	.965	1.11	.....
he year	5,440	.....	639	2.50	33.91	.....

[a] One day minimum controlled by pondage.
[b] Approximate, owing to ice obstruction.
[c] At Salisbury Inlet.

SCHOHARIE CREEK AT PRATTSVILLE, N. Y.

Schoharie Creek above Prattsville drains a rugged mountainous area almost entirely wooded. The watershed, embracing an area of 243 square miles, lies wholly within Greene County. The basin is surrounded by continuous mountain ranges, and intervening ridges divide the main stream from its principal tributaries, Batavia Kill, East Kill, and West Kill. A gaging station was established at the highway bridge in the village of Prattsville, November 7, 1902, by C. C. Covert; the gage datum is referred to the United States Geological Survey bench mark, an "O" marked on a bowlder on the right-hand end of the bridge on the downstream side; elevation 1,151 feet. A 15-foot weight and wire gage, having a boxed horizontal scale, is attached to the steel floor beams of the bridge on the upstream side. The elevation of the water surface when the gage reads zero is 1,130.03. The bridge has a single span of 185 feet. In extreme low water the current underneath the bridge is sluggish and meter measurements are made by fording the stream a short distance below the bridge. The great freshet of October 9–11, 1903, apparently changed the stream bed and cross section in the vicinity of the gage. Measurements made during 1903 and 1904 have been applied toward the construction of a new rating curve.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Schoharie Creek at Prattsville, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Feet per sec.*	*Feet.*	*Sec.-feet.*
July 1	R. E. Horton	404	0.71	5.00	287
September 21	C. C. Covert	269	.26	4.45	71
September 21	do	65	1.08	4.45	[a]70
October 23	C. C. Covert and E. F. Weeks.	775	1.50	6.16	1,117
October 23	do	693	1.44	6.00	998
October 24	do	682	1.11	5.72	756

[a] Wading below station.

Mean daily gage height, in feet, of Schoharie Creek at Prattsville, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.56	5.34	5.85	5.59	6.42	5.61	5.00	4.50	4.35	4.60	4.80	5.10
2	5.56	5.21	5.70	7.39	6.09	5.21	4.65	4.50	4.35	4.50	4.80	5.10
3	5.96	5.71	7.55	6.14	5.88	4.98	4.52	4.50	4.35	4.45	4.75	5.35
4	5.96	5.81	5.95	5.76	5.68	4.95	4.48	4.50	4.30	4.40	4.70	5.40
5	5.96	5.76	5.50	5.64	5.58	4.78	4.40	4.45	4.50	4.40	4.68	5.40
6	5.96	6.21	5.35	5.79	5.43	4.83	4.35	4.40	4.42	4.40	4.70	5.30
7	5.96	8.36	8.23	5.94	5.33	5.13	4.38	4.38	4.35	4.25	4.70	5.20
8	5.86	6.85	7.75	5.89	5.23	5.05	4.38	4.32	4.35	4.35	4.70	5.15
9	5.86	5.90	6.15	6.49	5.23	7.58	4.32	4.30	4.35	4.28	4.70	5.10
10	5.71	5.55	5.65	6.74	5.18	6.78	4.32	4.70	4.35	4.32	4.70	4.80
11	5.64	5.30	5.55	6.24	5.18	5.98	4.40	4.95	4.35	4.35	4.70	4.70
12	5.58	5.27	5.40	5.99	5.11	5.57	4.40	4.80	4.32	4.62	4.70	4.90
13	5.51	5.70	5.20	5.74	5.03	5.35	4.40	4.70	4.30	4.90	4.70	4.90
14	5.51	5.80	5.25	5.56	5.01	5.27	4.35	4.70	4.32	4.80	4.78	4.60
15	5.51	5.55	5.07	5.42	5.28	5.12	4.32	4.70	4.52	4.70	5.00	4.25
16	5.48	5.55	5.05	5.32	5.88	5.00	4.35	4.65	4.95	4.65	4.85	4.40
17	5.46	5.55	5.05	5.26	5.61	4.92	4.30	4.62	4.68	4.60	4.80	4.90
18	5.46	5.50	5.00	5.22	5.43	4.82	4.72	4.60	4.48	4.60	4.75	5.00
19	5.44	5.55	5.05	5.34	5.18	4.74	4.68	4.52	4.40	4.55	4.80	5.10
20	5.36	5.85	5.65	5.19	5.68	4.72	4.40	4.75	4.30	4.50	4.90	5.10
21	5.36	5.83	5.20	5.19	5.58	4.70	4.35	4.98	4.42	8.90	5.55	5.10
22	5.38	6.95	5.46	5.14	5.33	4.62	4.40	4.85	4.35	7.50	6.00	5.10
23	7.88	6.00	6.74	5.14	5.21	4.62	4.35	4.70	4.28	6.15	5.70	5.18
24	6.61	5.95	6.04	5.09	5.21	4.57	4.30	4.60	4.30	5.72	5.50	5.90
25	5.76	5.85	6.52	5.22	5.13	4.52	4.35	4.50	4.38	5.45	5.45	5.65
26	5.54	5.70	8.54	6.44	5.21	4.47	4.40	4.48	4.38	5.30	5.15	5.40
27	5.36	5.85	6.92	6.09	5.68	4.42	4.35	4.40	4.40	5.20	5.10	6.57
28	5.31	5.85	6.24	8.49	5.28	4.42	4.35	4.40	4.40	5.10	5.10	7.68
29	5.36	5.75	5.64	7.69	5.13	4.42	5.20	4.40	4.40	5.00	5.15	5.92
30	5.26	.....	5.44	6.69	5.23	4.52	4.75	4.40	4.60	5.00	5.10	5.60
31	5.26	.....	5.46	.....	5.48	.....	4.60	4.35	.....	4.95	.....	5.50

Rating table for Schoharie Creek at Prattsville, N. Y., from November 9, 1902, to October 10, 1903.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.60	8	6.50	997	8.40	3,780	10.30	9,200
4.70	27	6.60	1,100	8.50	3,970	10.40	9,600
4.80	48	6.70	1,210	8.60	4,212	10.50	10,000
4.90	74	6.80	1,330	8.70	4,454	10.60	10,400
5.00	103	6.90	1,455	8.80	4,696	10.70	10,800
5.10	135	7.00	1,580	8.90	4,938	10.80	11,200
5.20	168	7.10	1,710	9.00	5,180	10.90	11,600
5.30	208	7.20	1,840	9.10	5,440	11.00	12,000
5.40	252	7.30	1,980	9.20	5,700	11.10	12,460
5.50	305	7.40	2,120	9.30	5,960	11.20	12,920
5.60	350	7.50	2,270	9.40	6,220	11.30	13,380
5.70	404	7.60	2,420	9.50	6,480	11.40	13,840
5.80	462	7.70	2,570	9.60	6,784	11.50	14,300
5.90	523	7.80	2,730	9.70	7,088	11.60	14,840
6.00	590	7.90	2,890	9.80	7,392	11.70	15,380
6.10	660	8.00	3,060	9.90	7,696	11.80	15,920
6.20	733	8.10	3,230	10.00	8,000	11.90	16,460
6.30	815	8.20	3,410	10.10	8,400	12.00	17,000
6.40	904	8.30	3,590	10.20	8,800		

Logarithmic extension used above 8.0 feet gage height.

Rating table for Schoharie Creek at Prattsville, N. Y., from October 11, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.15	0	4.90	245	6.00	975	7.10	2,260
4.20	12	5.00	285	6.10	1,070	7.20	2,390
4.25	24	5.10	345	6.20	1,170	7.30	2,540
4.30	36	5.20	405	6.30	1,270	7.40	2,680
4.35	48	5.30	465	6.40	1,370	7.50	2,830
4.40	61	5.40	525	6.50	1,470	7.60	2,990
4.45	73	5.50	585	6.60	1,600	7.70	3,150
4.50	85	5.60	663	6.70	1,720	7.80	3,300
4.60	125	5.70	741	6.80	1,850	7.90	3,460
4.70	165	5.80	819	6.90	1,970	8.00	3,620
4.80	205	5.90	897	7.00	2,100		

discharge, in second-feet, of Schoharie Creek at Prattsville, N. Y., 1902–1904

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	168
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	168
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	350
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	310
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	252	276
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	252	252
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	252	230
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	252	208
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	230	168
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208	168
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208	168
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208	168
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208	2,350
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208	1,840
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	168	718
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	168	590
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	168	556
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	168	5,960
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	135	1,980
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	135	923
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	230	696
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	276	625
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	252	523
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	325	492
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208	474
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208	416
...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	416
...	366	556	2,610	1,120	188	38	433	97	1,710	88	345	285
...	377	393	1,190	718	176	38	340	74	733	97	285	345
...	682	1,160	833	718	176	38	252	74	462	88	265	345
...	774	1,330	675	860	168	38	168	80	325	88	255	345
...	492	774	639	660	161	88	168	474	290	88	245	330
...	404	625	625	590	135	31	168	492	290	103	.....	265
...	404	625	523	590	135	31	161	450	252	97	275	245
...	393	523	815	696	135	31	135	276	243	733	255	245
...	377	492	2,080	1,580	135	61	109	208	188	(a)	255	235
...	377	433	1,580	904	119	44	103	217	168	7,390	245	205
...	404	404	3,320	696	129	74	103	176	176	3,685	235	205
...	404	1,460	1,910	590	103	2,850	88	168	168	2,050	235	205
...	377	733	1,310	511	97	1,840	74	142	142	1,580	225	205
...	377	462	1,050	462	108	815	74	135	142	1,170	205	936
...	404	416	1,310	1,270	103	1,910	74	103	109	986	205	819
...	404	660	1,050	950	108	1,840	61	108	135	741	215	741
...	377	696	923	860	88	860	61	108	142	682	540	741
...	377	(b)	774	696	74	625	69	103	511	702	800	663
...	377	.....	696	577	74	462	88	108	276	682	975	663
...	377	.....	660	492	61	377	103	1,050	168	570	702	2,830
...	404	.....	749	450	61	1,645	377	815	161	495	465	2,610

a Above rating curve. b Frozen.

Mean daily discharge, in second-feet, of Schoharie Creek at Prattsville, N. Y., etc.—Cont'd

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	De
1903.												
22	450	.....	3,410	393	61	1,520	340	696	135	465	405	1,
23	361	.....	7,315	252	61	1,190	217	646	129	435	420	
24	377	.....	3,780	350	61	2,460	161	511	119	450	405	
25	355	.....	1,910	300	48	1,270	109	556	109	435	390	
26	590	.....	1,270	300	48	815	97	696	103	420	435	
27	523	.....	886	276	48	556	80	416	103	390	465	
28	815	.....	660	243	48	433	74	860	119	390	.....	
29	.....	.....	625	217	48	462	80	4,575	109	390	405	
30	2,340	.....	523	200	48	718	142	2,770	103	360	315	
31	749	.....	2,270	.....	44	.....	109	2,650	.....	345	.....	
1904.												
1	624	495	(a)	663	1,400	663	285	85	48	125	205	
2	624	(a)	.....	2,680	1,070	405	145	85	48	85	205	
3	936	.....	.....	1,120	878	275	95	85	48	73	185	
4	(a)	.....	.....	780	721	265	79	85	36	61	165	
5	.....	.....	.....	702	643	195	61	73	85	61	155	
6	.....	.....	.....	819	540	215	48	61	67	61	165	
7	.....	.....	.....	936	480	360	54	54	48	24	165	
8	.....	.....	.....	897	420	315	54	42	48	48	165	
9	.....	.....	.....	1,470	420	2,950	42	36	48	31	165	
10	.....	.....	.....	1,750	390	1,820	42	165	48	42	165	
11	.....	.....	.....	1,220	390	917	61	265	48	48	165	
12	.....	.....	.....	975	345	643	61	205	42	135	165	
13	.....	.....	.....	780	300	495	61	165	36	245	165	
14	.....	.....	.....	624	285	450	48	165	42	205	195	
15	.....	.....	.....	540	450	360	42	165	95	165	285	
16	.....	.....	.....	480	878	285	48	145	265	145	225	
17	.....	.....	.....	435	663	255	36	135	155	125	205	
18	.....	.....	.....	420	540	215	175	125	79	125	185	
19	.....	.....	.....	495	390	185	155	95	61	105	205	
20	.....	.....	(a)	405	721	175	61	185	36	85	245	
21	.....	.....	405	405	643	165	48	275	67	(b)	624	
22	(a)	.....	555	375	480	135	61	225	48	2,830	975	
23	3,420	.....	1,780	375	405	135	48	165	31	1,120	741	
24	1,600	.....	1,000	345	405	115	36	125	36	760	585	
25	780	.....	1,500	420	360	95	48	85	54	555	555	
26	624	.....	(b)	1,420	405	79	61	79	54	465	375	
27	495	.....	2,010	1,070	721	67	48	61	61	405	345	1
28	465	.....	1,220	(b)	450	67	48	61	61	345	345	3
29	495	.....	702	3,150	360	67	405	61	61	285	375	
30	435	.....	555	1,720	420	95	185	61	125	285	345	
31	435	.....	555	.....	570	.....	125	48	.....	265	.....	

a Stream frozen over; no record. b Above rating table.

nated monthly discharge of Schoharie Creek at Prattsville, N. Y., 1902–1904.

[Drainage area, 240 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1902.					
ıer, 22 days	325	135	214	0.892	0.730
er	5,960	168	722	3.01	3.47
1903.					
, 30 days	2,340	361	516	2.15	2.40
y, 17 days	1,460	393	691	2.88	1.82
	7,315	523	1,547	6.45	7.44
	1,580	200	617	2.57	2.87
	188	44	98	.408	.470
	2,850	31	770	3.21	3.58
	433	61	149	.621	.716
	4,575	74	639	2.66	3.07
ıer	1,710	103	261	1.09	1.22
, 30 days	(a)	88	870	3.62	4.17
ıer, 28 days	975	205	374	1.56	1.62
er	2,830	205	662	2.76	3.18
1904.					
, 12 days [b]	3,420	435	911	3.80	1.70
y [b]					
10 days [b]	(a)	405	1,028	4.28	1.59
9 days	(a)	345	947	3.95	4.26
	1,400	285	553	2.30	2.65
	3,070	67	415	1.73	1.93
	405	36	89	.371	.428
	275	36	118	.492	.567
ıer	265	31	66	.275	.307
, 30 days	(a)	24	310	1.29	1.44
ıer	975	155	302	1.26	1.41
er	3,110	24	521	2.17	2.50

: rating table. [b] Stream frozen over January 4 to 22 and February 2 to March 20.

BATAVIA KILL NEAR PRATTSVILLE, N. Y.

ıvia Kill enters Schoharie Creek just above Prattsville. The ; of this stream at Windon near the headwaters was made Sep- r 10, 1903, by F. H. Tillinghast. The discharge was 21 second-

CATSKILL CREEK AT SOUTH CAIRO, N. Y.

The drainage basin of this stream receives the run-off from the north slope of the Catskill Range, and lies, for the most part, in the timbered highlands of Greene County. The stream enters tide water of Hudson River at Catskill. The topography of the drainage area is shown on the Durham, Coxsackie, and Catskill sheets of the United States Geological Survey Topographic Atlas. The stream flows over a rock bed through much of its course. The slopes of the drainage basin are precipitous; there are no lakes and little artificial storage.[a] The gaging station, which was established July 4, 1901, is located at the highway bridge in the village of South Cairo. The bridge has a single span of 194.5 feet between abutments. The stream channel is rock overlain in some places with earth. The stream stage is observed each morning and night from a weight and chain gage which is attached to the bridge, and whose elevation is referred to a "0" near outer corner on upstream side of bridge seat on right-hand abutment. The elevation of bench mark is assumed to be 100 feet, the elevation of water surface when gage reads zero is 78.71 feet. Special discharge measurements have been made in the winter to determine the calibration curve for the stream cross section in the presence of ice; a correction coefficient to be applied to the measured discharge as taken at 0.6 depth has also been obtained by means of numerous vertical-velocity curves. The erection of a dam a short distance below the gage for purposes of boating necessitates withholding a portion of the record for 1904 until additional measurements can be made.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Catskill Creek at South Cairo, N. Y., in 1904.

Date.	Hydrographer.	Area.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Feet per sec.*	*Feet.*	*Second-fe*
June 28[c]	R. E. Horton	45	1.10	2.62	[illegible]
September 16	Covert and Swancott	272	.32	2.90	[illegible]

[a] Water power of this stream is described in Report on Stream Gagings, contained in Supplemen Report of State Engineer and Surveyor of New York, 1902, pp. 260 to 264.
[b] Discharge affected by dam one-fourth mile below station.
[c] By wading 500 feet upstream.

an daily gage height, in feet, of Catskill Creek at South Cairo, N. Y., for 1904.

y.	Jan.	Feb.	Mar.	Apr.	May.	June.[a]	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	4.29	4.56	3.50	5.24	5.04	3.38	3.00	2.45	2.30	2.40	3.10	3.65
.....	4.17	4.46	3.45	7.19	4.59	3.23	2.80	2.40	2.20	2.40	3.00	3.35
.....	4.32	4.31	3.50	5.69	4.54	3.23	2.50	2.40	2.10	2.40	2.90	3.20
.....	4.17	4.66	5.55	4.59	4.39	3.13	2.50	2.40	2.40	2.40	2.80	3.30
.....	4.17	4.56	6.05	4.74	4.18	4.23	2.55	2.40	2.20	2.50	2.85	3.25
.....	4.12	4.26	5.40	4.84	4.03	3.58	2.40	2.40	2.20	2.40	2.90	3.10
.....	4.07	4.28	8.20	4.94	3.88	3.43	2.35	2.30	2.20	2.40	2.90	3.00
.....	3.92	6.98	7.90	4.89	3.73	3.83	2.30	2.30	2.30	2.40	2.80	2.90
.....	3.87	4.51	5.85	5.29	3.58	9.15	2.40	2.40	2.30	2.30	2.70	3.00
.....	3.82	4.86	4.88	5.24	3.53	6.75	2.50	2.40	2.30	2.30	2.70	2.75
.....	3.72	4.58	4.20	4.80	3.48	5.25	2.40	2.50	2.30	2.40	2.60	2.40
.....	3.62	4.31	4.30	4.69	3.33	4.67	2.40	2.60	2.30	2.50	2.60	2.20
.....	3.57	3.52	4.20	4.49	3.28	4.17	2.30	2.45	2.20	2.60	2.60	2.30
.....	3.47	4.24	4.30	4.29	3.13	4.02	2.30	2.45	2.30	2.70	3.00	2.40
.....	3.52	4.08	3.90	4.14	3.28	3.92	2.30	2.50	3.10	2.60	3.00	2.40
.....	3.47	4.01	3.65	4.09	4.51	3.72	2.30	2.40	2.70	2.50	3.40	2.60
.....	3.36	3.88	3.20	4.19	4.13	3.52	2.30	2.35	2.50	2.50	3.40	2.75
.....	3.36	3.86	3.80	4.39	3.88	3.42	2.45	2.40	2.30	2.50	3.40	2.65
.....	3.36	4.01	3.90	4.59	4.08	3.27	2.40	2.40	2.30	2.50	3.35	2.70
.....	3.35	3.88	5.20	4.14	4.13	3.02	2.40	2.30	2.30	2.60	3.15	2.80
.....	3.35	3.61	5.05	3.89	3.88	2.92	2.40	2.30	2.30	4.75	3.80	2.80
.....	3.44	4.26	4.95	3.89	3.63	2.92	2.30	2.30	2.30	5.30	4.70	2.80
.....	5.14	4.87	7.10	3.94	3.48	2.92	2.30	2.40	2.30	4.55	4.60	3.00
.....	5.26	4.73	6.40	3.84	3.33	2.72	2.20	2.40	2.30	4.15	4.60	3.10
.....	4.51	3.90	6.80	3.94	3.23	2.62	2.30	2.40	2.30	3.95	4.45	3.10
.....	4.36	3.63	8.35	3.94	3.73	2.62	2.30	2.40	2.20	3.80	4.05	3.20
.....	4.54	3.50	7.35	4.32	4.23	2.52	2.40	2.35	2.30	3.70	3.85	3.40
.....	4.96	3.30	5.55	8.54	3.63	2.52	2.40	2.30	2.30	3.60	3.80	6.15
.....	4.96	3.35	4.40	6.76	3.33	2.50	2.75	2.20	2.30	3.35	3.80	4.90
.....	4.96	.....	4.60	5.79	3.33	2.70	2.60	2.20	2.45	3.20	3.90	4.00
.....	4.96	.....	4.59	.....	3.48	.....	2.55	2.20	.....	3.10	.....	3.80

[a] After June 1 gage heights affected by dam below station.

Rating table for Catskill Creek at South Cairo, N. Y., for open section from July 4, 1901, to June 1, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.20	16	4.20	401	6.40	1,900	10.40	11,764
2.30	20	4.30	449	6.60	2,106	10.60	12,700
2.40	24	4.40	498	6.80	2,328	10.80	13,700
2.50	28	4.50	546	7.00	2,550	11.00	14,700
2.60	37	4.60	602	7.20	2,822	11.20	15,780
2.70	45	4.70	657	7.40	3,094	11.40	16,860
2.80	55	4.80	712	7.60	3,406	11.60	18,000
2.90	63	4.90	768	7.80	3,758	11.80	19,200
3.00	72	5.00	824	8.00	4,110	12.00	20,400
3.10	88	5.10	885	8.20	4,562	12.20	21,920
3.20	104	5.20	946	8.40	5,014	12.40	23,440
3.30	120	5.30	1,006	8.60	5,498	12.60	25,000
3.40	136	5.40	1,067	8.80	6,014	12.80	26,600
3.50	152	5.50	1,128	[a] 9.00	6,530	13.00	28,200
3.60	182	5.60	1,206	9.20	7,178	13.50	34,000
3.70	213	5.70	1,285	9.40	7,826	14.00	39,800
3.80	243	5.80	1,363	9.60	8,524	14.50	45,600
3.90	274	5.90	1,442	9.80	9,272	15.00	51,400
4.00	304	6.00	1,520	10.00	10,020	15.50	57,200
4.10	352	6.20	1,710	10.20	10,892	16.00	63,000

[a] Extension by logarithmic diagram above 9.1.

Mean daily discharge, in second-feet, of Catskill Creek at South Cairo, N. Y., for 1904

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	(a)	(a)	(a)	970	848	17	.....	.....	104	396	[illegible]
2	.....	.....	.....	2,810	596	18	.....	.....	243	498	[illegible]
3	.....	.....	.....	1,280	568	19	.....	.....	274	596	[illegible]
4	.....	.....	1,170	596	493	20	.....	.....	946	372	[illegible]
5	.....	.....	1,570	679	391	21	.....	.....	854	270	[illegible]
6	.....	.....	1,070	735	318	22	.....	.....	796	270	[illegible]
7	.....	440	4,560	791	268	23	909	.....	2,690	286	[illegible]
8	.....	2,530	3,930	763	222	24	982	.....	1,900	255	[illegible]
9	.....	552	1,400	1,000	176	25	552	.....	2,330	286	[illegible]
10	.....	746	729	970	161	26	478	.....	4,900	286	[illegible]
11	.....	590	401	763	149	27	(a)	.....	3,030	459	
12	.....	454	449	652	125	28	.....	.....	1,170	5,340	
13	.....	158	401	541	117	29	.....	.....	498	2,280	
14	.....	420	449	444	93	30	.....	.....	602	1,360	
15	.....	343	274	372	117	31	.....	.....	596	.....	
16	.....	(a)	198	348	552						

[a] Stream frozen over during remainder of month.

ted monthly discharge of Catskill Creek at South Cairo, N. Y., for 1904.

[Drainage area, 263 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
days [a]	982	478	730	2.78	0.414
9 days [a]	2,530	158	693	2.64	0.884
days [a]	4,900	104	1,340	5.10	5.31
	5,340	255	889	3.38	3.77
	848	93	278	1.06	1.22

[a] Stream frozen over during remainder of month.

ESOPUS CREEK NEAR OLIVEBRIDGE, N. Y.

:h wire cable, 168-feet span, was erected across the stream above Bishops Falls, May 25, 1903. A cantilever was also 18 feet over the stream from an abandoned bridge abutment. is a weight and chain gage was placed. The stream was twice each day by Jesse B. Boice. This station is located site of a proposed storage reservoir. The bed of the stream nd the banks bold. No overflow takes place. The gaging in the heart of a precipitous timber-covered mountain drain-ı. There is no storage control of the stream above. The ırk is a chisel draft at upstream corner of the right-hand ; of the abandoned bridge. The elevation of water surface ;e reads zero is 81.86. This station site was selected by, and ;way erected for, the engineers of the New York Water-Commission, to show the relation between the discharge at t and at Kingston. Owing to the formation of a gravel bar ɔuth of a tributary entering at the cableway the record was ued in July, 1904.

servations at this station during 1904 have been made under tion of R. E. Horton, district hydrographer.

:harge measurements of Esopus Creek near Olivebridge, N. Y., in 1904.

	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.[a]
		Sq. feet.	*Feet per sec.*	*Feet.*	*Sec.-feet.*
.....	R. E. Horton	158	1.11	1.35	143

[a] Gravel Island, upstream angle varies.

Mean daily gage height, in feet, of Esopus Creek near Olivebridge, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	1.82	1.94	1.71	3.19	2.96	1.66	17	2.36	1.76	1.79	2.16	2.03	1.87
2	1.78	1.72	1.77	3.35	2.67	1.70	18	2.38	1.77	1.90	2.09	2.02	1.73
3	1.77	1.82	2.12	2.96	2.50	1.81	19	2.36	1.88	1.97	2.04	2.11	1.67
4	1.72	1.74	2.20	2.63	2.38	1.67	20	2.42	1.89	2.25	1.96	2.30	1.67
5	1.70	1.79	1.93	2.57	2.26	1.61	21	2.48	1.85	2.09	1.94	2.16	1.64
6	1.72	1.77	1.87	2.49	2.18	1.61	22	2.74	1.86	2.07	1.90	2.06	1.61
7	2.08	2.86	3.25	2.67	2.10	1.96	23	3.60	2.34	2.65	1.86	2.01	1.56
8	2.56	3.18	4.45	2.81	2.02	1.94	24	2.68	2.09	2.77	1.84	1.97	1.59
9	2.60	2.52	3.27	3.49	1.97	3.20	25	2.28	1.94	3.05	1.91	1.94	1.47
10	2.66	2.30	2.78	3.55	1.91	3.15	26	2.20	1.81	5.21	2.07	1.93	1.41
11	2.62	2.26	2.53	3.08	1.89	2.49	27	2.12	1.91	4.03	2.12	1.88	1.35
12	2.62	2.10	2.33	2.81	1.81	2.25	28	1.97	1.87	3.15	3.89	1.80	1.81
13	1.94	2.07	2.25	2.61	1.76	2.06	29	2.04	1.77	2.75	3.78	1.70	1.31
14	2.50	2.04	2.12	2.44	1.72	1.99	30	1.97	.....	2.52	3.21	1.70	1.41
15	2.38	1.96	2.05	2.30	2.06	1.87	31	1.96	.....	2.42	.....	1.67	.....
16	2.38	1.78	1.97	2.27	2.20	1.87							

Rating table for Esopus Creek near Olivebridge, N. Y., from May 25, 1903, to June 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	55	2.30	815	3.60	2,610	4.90	5,100
1.10	81	2.40	911	3.70	2,770	5.00	5,320
1.20	107	2.50	1,010	3.80	2,940	5.10	5,560
1.30	138	2.60	1,140	3.90	3,100	5.20	5,790
1.40	173	2.70	1,280	4.00	3,270	5.30	6,030
1.50	208	2.80	1,420	4.10	3,460	5.40	6,260
1.60	263	2.90	1,550	4.20	3,650	5.50	6,500
1.70	318	3.00	1,690	4.30	3,840	5.60	6,760
1.80	381	3.10	1,840	4.40	4,030	5.70	7,020
1.90	453	3.20	1,990	4.50	4,220	5.80	7,280
2.00	525	3.30	2,140	4.60	4,440	5.90	7,540
2.10	622	3.40	2,290	4.70	4,660	6.00	7,800
2.20	718	3.50	2,440	4.80	4,880		

NOTE.—Discharge for gage heights above 5 feet from logarithmic extension of rating curve.

Mean daily discharge, in second-feet, of Esopus Creek near Olivebridge, N. Y., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	.....	.....	.....	.....	.....	60	815	124	1,975	117	307	323
2	.....	.....	.....	.....	.....	68	622	110	1,392	112	301	318
3	.....	.....	.....	.....	.....	65	482	104	970	112	296	285
4	.....	.....	.....	.....	.....	39	453	155	796	97	285	328
5	.....	.....	.....	.....	.....	52	410	1,140	622	112	381	381
6	.....	.....	.....	.....	.....	55	340	670	511	115	323	323
7	.....	.....	.....	.....	.....	52	307	699	439	104	241	219
8	.....	.....	.....	.....	.....	117	268	475	367	892	274	213
9	.....	.....	.....	.....	.....	152	252	395	329	(a)	274	208
10	.....	.....	.....	.....	.....	84	230	367	296	7,020	274	235
11	.....	.....	.....	.....	.....	124	201	307	252	3,202	263	274
12	.....	.....	.....	.....	.....	3,940	183	381	235	2,110	257	307
13	.....	.....	.....	.....	.....	2,290	187	285	230	1,446	241	1,406
14	.....	.....	.....	.....	.....	1,662	152	252	208	1,080	230	603
15	.....	.....	.....	.....	.....	2,290	141	219	187	931	230	439
16	.....	.....	.....	.....	.....	1,840	131	246	176	737	252	439
17	.....	.....	.....	.....	.....	1,308	97	241	489	660	796	410
18	.....	.....	.....	.....	.....	1,010	99	208	544	853	1,080	367
19	.....	.....	.....	.....	.....	815	208	187	323	699	853	279
20	.....	.....	.....	.....	.....	853	159	1,080	263	670	680	1,676
21	.....	.....	.....	.....	.....	3,202	252	641	230	603	583	2,706
22	.....	.....	.....	.....	.....	2,260	180	453	208	544	564	1,480
23	.....	.....	.....	.....	.....	2,220	345	410	201	544	535	980
24	.....	.....	.....	.....	.....	3,460	219	374	180	518	503	825
25	.....	.....	.....	.....	94	2,290	173	352	169	511	446	815
26	.....	.....	.....	.....	81	1,480	152	381	159	388	359	825
27	.....	.....	.....	.....	60	1,080	134	307	159	367	340	482
28	.....	.....	.....	.....	73	796	127	395	166	352	352	467
29	.....	.....	.....	.....	68	1,088	110	7,072	145	345	296	395
30	.....	.....	.....	.....	68	931	145	3,992	131	340	329	446
31	.....	.....	.....	.....	68	.....	148	3,308	.....	312	.....	403
1904.												
1	395	482	323	1,975	1,634	296	296	.....	.....	.....	.....	.....
2	367	329	359	2,220	1,238	398	190	.....	.....	.....	.....	.....
3	359	395	641	1,634	1,010	388	159	.....	.....	.....	.....	.....
4	329	340	718	1,182	892	301	145	.....	.....	.....	.....	.....
5	318	374	475	1,101	776	268	.....	.....	.....	.....	.....	.....
6	329	359	431	1,000	699	268	.....	.....	.....	.....	.....	.....
7	603	1,498	2,060	1,238	622	496	.....	.....	.....	.....	.....	.....
8	1,088	1,960	4,120	1,433	544	482	.....	.....	.....	.....	.....	.....
9	1,140	1,036	2,095	2,425	503	1,990	.....	.....	.....	.....	.....	.....
10	1,224	815	1,392	2,520	460	1,920	.....	.....	.....	.....	.....	.....
11	1,168	776	1,049	1,810	446	1,000	.....	.....	.....	.....	.....	.....
12	1,168	622	844	1,433	388	766	.....	.....	.....	.....	.....	.....
13	482	593	766	1,154	352	583	.....	.....	.....	.....	.....	.....
14	1,010	564	641	951	329	518	.....	.....	.....	.....	.....	.....
15	892	496	573	815	583	431	.....	.....	.....	.....	.....	.....
16	892	367	503	786	718	431	.....	.....	.....	.....	.....	.....
17	873	352	374	680	554	431	.....	.....	.....	.....	.....	.....
18	892	359	453	612	544	334	.....	.....	.....	.....	.....	.....
19	873	439	503	564	632	301	.....	.....	.....	.....	.....	.....
20	931	446	766	496	815	301	.....	.....	.....	.....	.....	.....

a Above rating table.

Mean daily discharge, in second-feet, of Esopus Creek near Olivebridge, N. Y., etc.—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
21	990	417	612	482	680	285	.....	.....	.....	.....	.....	.....
22	1,336	424	593	458	583	268	.....	.....	.....	.....	.....	.....
23	2,610	853	1,210	424	535	241	.....	.....	.....	.....	.....	.....
24	1,252	612	1,378	410	503	208	.....	.....	.....	.....	.....	.....
25	796	482	1,760	460	482	197	.....	.....	.....	.....	.....	.....
26	718	388	5,814	593	475	176	.....	.....	.....	.....	.....	.....
27	641	460	3,327	641	439	155	.....	.....	.....	.....	.....	.....
28	503	431	1,920	3,084	381	388	.....	.....	.....	.....	.....	.....
29	564	359	1,350	2,906	318	141	.....	.....	.....	.....	.....	.....
30	503	.....	1,036	2,005	318	187	.....	.....	.....	.....	.....	.....
31	496	.....	931	.....	301	.....	.....	.....	.....	.....	.....	.....

Estimated monthly discharge of Esopus Creek near Olivebridge, N. Y., for 1903 and 1904.

[Drainage area, 242 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
May 25–31	94	60	73	0.302	0.079
June	3,940	39	1,189	4.91	5.48
July	815	97	249	1.03	1.19
August	7,072	104	817	3.38	3.90
September	1,975	131	412	1.70	1.90
October, 30 days	([a])	97	863	3.57	3.98
November	1,080	230	405	1.67	1.86
December	2,706	208	608	2.51	2.89
1904.					
January	2,610	318	830	3.43	3.95
February	1,960	329	587	2.43	2.62
March	5,814	323	1,259	5.20	6.00
April	3,084	410	1,250	5.17	5.77
May	1,634	301	605	2.50	2.88
June	1,990	141	472	1.95	2.18

[a] Above rating table.

ESOPUS CREEK AT KINGSTON, N. Y.

A gaging station was established at the Washington Street Bridge on Esopus Creek, in Kingston, N. Y., July 5, 1901. The stage of the stream has been observed twice each day from a chain and weight gage attached to the bridge. In winter and at times when the stream

more or less obstructed by ice special discharge measurements e made from which a rating curve applicable to periods when the am was frozen have been derived. This gives a considerably ller discharge at a given stage of the stream than does a regular ng curve for the cross section derived from the measurements in n section.

'he observations at this station during 1904 have been made under direction of R. E. Horton, district hydrographer.

Discharge measurements of Esopus Creek at Kingston, N. Y., in 1904.

Date.	Hydrographer.	Area.	Mean velocity.	Gage height.	Discharge.
		Sq. ft.	*Ft. per sec.*	*Feet.*	*Second-feet.*
e 20	R. E. Horton	255	0.84	4.72	214
tember 15	Covert and Swancott	506	2.28	7.18	[a] 1,161
tember 19	do	269	1.04	5.15	281

[a] Approximate; stream rising rapidly.

Mean daily gage height, in feet, of Esopus Creek at Kingston, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	7.61	7.41	7.26	10.85	9.35	5.44	6.27	4.32	4.37	4.82	5.58	5.52
	7.41	6.16	7.26	11.48	8.60	5.40	5.18	4.32	4.30	4.58	5.48	5.50
	6.71	7.01	7.36	10.13	8.05	5.80	4.85	4.28	4.31	4.50	5.38	5.55
	6.26	6.96	9.45	9.08	7.70	5.50	4.74	4.29	4.81	4.52	5.30	5.88
	6.71	6.81	8.15	8.62	7.37	5.31	4.65	4.19	4.70	4.32	5.25	5.40
	6.69	6.73	7.74	8.41	7.09	5.30	4.62	4.22	4.57	4.32	5.32	5.32
	6.89	7.46	9.26	8.53	6.85	6.72	4.66	4.09	4.36	4.38	5.32	5.42
	6.83	12.17	18.23	8.92	6.63	6.27	4.65	4.11	4.29	4.30	5.15	5.30
	6.71	9.85	14.85	10.07	6.46	12.14	4.59	4.19	4.30	4.25	5.10	5.29
	6.81	8.99	12.18	10.89	6.32	11.14	4.48	4.21	4.31	4.28	5.10	4.90
	6.71	8.51	10.95	9.82	6.19	6.63	4.48	6.25	4.29	4.35	5.02	4.80
	6.46	8.31	10.00	9.03	6.06	7.91	4.45	5.04	4.09	4.42	4.98	4.74
	6.36	7.86	9.10	8.47	5.92	7.23	4.45	4.76	4.24	4.90	4.90	5.12
	6.41	7.76	8.65	8.00	5.82	6.79	4.34	4.62	4.44	4.88	5.80	5.00
	6.37	7.56	8.25	7.62	5.92	6.46	4.30	4.46	7.22	4.70	5.65	4.88
	6.26	7.41	7.80	7.52	7.28	6.19	4.28	4.42	6.54	4.54	5.62	5.18
	6.16	6.99	7.40	7.22	6.83	5.93	4.33	4.26	5.68	4.50	5.72	5.12
	5.99	6.86	7.60	7.09	6.62	5.71	4.59	4.36	5.33	4.60	5.52	5.08
	5.79	6.92	7.10	6.86	6.73	5.50	4.88	4.52	5.14	4.58	5.42	5.12
	5.81	6.82	7.78	6.72	7.45	5.40	4.58	5.06	4.90	4.50	5.35	5.15
	5.76	6.72	8.39	6.58	7.01	5.29	4.36	6.11	4.80	11.29	5.88	5.12
	6.11	7.91	8.04	6.41	7.67	5.16	4.26	5.44	4.68	13.84	6.40	5.02
	7.96	9.73	9.02	6.27	6.45	5.01	4.28	5.31	4.62	9.09	6.25	5.05
	10.91	8.51	9.74	6.17	6.31	5.10	4.23	5.13	4.59	8.42	6.18	5.15
	9.41	8.09	9.95	6.21	6.08	4.95	4.10	4.83	4.52	7.20	6.12	5.80
	8.61	7.46	14.63	6.58	6.11	4.75	4.40	4.83	4.50	6.82	5.95	5.48
	8.26	7.41	13.66	6.75	6.11	4.70	4.33	4.65	4.55	6.55	5.70	5.45
	7.76	7.33	10.50	9.60	5.75	4.69	4.33	4.57	4.52	6.25	6.00	10.50
	7.66	7.31	9.20	11.53	5.58	4.70	4.18	4.47	4.50	6.02	5.92	9.65
	7.76	.....	8.40	9.85	5.51	4.72	4.82	4.44	4.70	5.85	6.00	8.71
	7.55	.....	8.28	.....	5.58	.....	4.51	4.37	.....	5.70	.....	8.18

Rating table for Esopus Creek at Kingston, N. Y., from July 5, 1901, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.50	8	6.60	741	11.20	3,620	17.20	9,940
3.60	22	6.70	782	11.40	3,800	17.40	10,180
3.70	36	6.80	823	11.60	3,980	17.60	10,420
3.80	49	6.90	864	11.80	4,160	17.80	10,660
3.90	63	7.00	905	12.00	4,340	18.00	10,900
4.00	77	7.10	950	12.20	4,528	18.20	11,220
4.10	94	7.20	995	12.40	4,716	18.40	11,540
4.20	110	7.30	1,040	12.60	4,909	18.60	11,840
4.30	127	7.40	1,085	12.80	5,107	18.80	12,120
4.40	143	7.50	1,130	13.00	5,305	19.00	12,400
4.50	160	7.60	1,179	13.20	5,499	19.20	12,720
4.60	180	7.70	1,227	13.40	5,693	19.40	13,040
4.70	200	7.80	1,276	13.60	5,888	19.60	13,340
4.80	220	7.90	1,324	13.80	6,084	19.80	13,620
4.90	240	8.00	1,373	14.00	6,280	20.00	13,900
5.00	260	8.20	1,480	14.20	6,484	20.20	14,240
5.10	285	8.40	1,587	14.40	6,688	20.40	14,580
5.20	309	8.60	1,700	14.60	6,894	20.60	14,920
5.30	334	8.80	1,820	14.80	7,102	20.80	15,260
5.40	358	9.00	1,940	[a] 15.00	7,310	21.00	15,600
5.50	383	9.20	2,074	15.20	7,522	21.50	16,500
5.60	412	9.40	2,208	15.40	7,734	22.00	17,400
5.70	441	9.60	2,348	15.60	7,950	22.50	18,350
5.80	469	9.80	2,495	15.80	8,170	23.00	19,300
5.90	498	10.00	2,642	16.00	8,390	23.50	20,300
6.00	527	10.20	2,797	16.20	8,666	24.00	21,300
6.10	562	10.40	2,952	16.40	8,942	24.50	22,350
6.20	596	10.60	3,112	16.60	9,204	25.00	23,400
6.30	631	10.80	3,276	16.80	9,452	25.50	24,500
6.40	665	11.00	3,440	17.00	9,700	26.00	25,600
6.50	700						

[a] Logarithmic extension above 15 feet.

daily discharge, in second-feet, of Esopus Creek at Kingston, N. Y., for 1904.

.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	955	868	808	3,320	2,170	368	620	130	138	224	406	389
.....	868	450	808	3,870	1,700	358	304	130	127	176	378	383
.....	608	707	848	2,740	1,400	469	230	123	128	160	353	397
.....	476	690	1,960	1,990	1,230	383	208	125	222	164	334	492
.....	608	641	1,220	1,710	1,070	335	190	108	200	130	321	[b]277
.....	608	616	1,020	1,590	946	334	184	113	174	130	339	257
.....	674	888	1,840	1,660	844	790	192	92	137	140	339	277
.....	649	3,710	([c])	1,890	753	620	190	95	125	127	297	257
.....	608	2,210	5,410	2,700	686	4,480	178	108	127	119	284	257
.....	641	1,680	3,710	3,360	638	3,570	157	112	128	123	284	180
.....	608	1,400	3,000	2,510	593	753	157	614	125	135	264	163
.....	529	1,300	2,310	1,960	548	1,330	152	270	92	147	256	146
.....	502	1,070	1,740	1,620	504	1,010	152	212	117	240	240	217
.....	516	1,020	1,480	1,370	475	819	133	184	150	236	469	197
.....	509	932	1,270	1,190	504	686	127	153	1,004	200	426	180
.....	476	868	1,050	1,140	1,030	593	123	147	716	168	418	237
.....	450	707	868	1,000	835	507	132	120	434	160	447	217
.....	410	658	955	945	742	443	178	137	341	180	389	217
.....	365	682	747	848	794	383	236	164	294	176	363	217
.....	365	649	1,270	790	1,110	358	176	274	240	160	346	237
.....	354	616	1,580	733	910	331	137	565	220	3,700	492	217
.....	436	1,090	1,390	669	1,210	299	120	368	196	6,120	665	197
.....	1,120	2,130	1,950	620	683	262	123	336	184	2,000	613	197
.....	2,900	1,400	2,450	586	634	285	115	292	178	1,600	589	237
.....	1,930	1,190	2,600	600	555	250	94	226	164	995	569	365
.....	1,460	888	6,920	733	565	210	143	226	160	831	512	297
.....	1,270	868	5,940	803	565	200	132	190	170	720	440	277
.....	1,030	838	3,030	2,350	455	198	132	174	164	613	527	[d]2,660
.....	978	828	2,070	3,910	406	200	107	155	160	534	504	2,050
.....	1,030	.....	1,590	2,530	386	204	224	150	200	484	527	1,510
.....	932	.....	1,520	.....	406	.....	162	138	.....	440	.....	1,240

[a] Record from January 1 to March 20 from ice curve.
[b] Record from December 5 to December 31, inclusive, from ice curve.
[c] Above rating table.
[d] Record approximate. Ice jam below bridge December 28 to 31.

Estimated monthly discharge of Esopus Creek at Kingston, N. Y., for 1904.

[Drainage area, 324.5 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
y	2,900	354	802	2.47	2.85
ry	3,710	450	1,089	3.36	3.62
30 days	6,920	747	2,112	6.51	7.26
.....	3,910	586	1,725	5.32	5.94
.....	2,170	386	818	2.52	2.91
.....	4,480	198	701	2.16	2.41
.....	620	94	178	.549	.633
.....	614	92	201	.619	.714
ber	1,004	92	227	.700	.781
r	6,120	119	688	2.12	2.44
ber	665	240	413	1.27	1.42
ber	2,660	146	466	1.44	1.66

Rating table for Esopus Creek at Kingston, N. Y., from July 5, 1901, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.50	8	6.60	741	11.20	3,620	17.20	9,940
3.60	22	6.70	782	11.40	3,800	17.40	10,180
3.70	36	6.80	823	11.60	3,980	17.60	10,420
3.80	49	6.90	864	11.80	4,160	17.80	10,660
3.90	63	7.00	905	12.00	4,340	18.00	10,900
4.00	77	7.10	950	12.20	4,528	18.20	11,220
4.10	94	7.20	995	12.40	4,716	18.40	11,540
4.20	110	7.30	1,040	12.60	4,909	18.60	11,840
4.30	127	7.40	1,085	12.80	5,107	18.80	12,120
4.40	143	7.50	1,130	13.00	5,305	19.00	12,400
4.50	160	7.60	1,179	13.20	5,499	19.20	12,720
4.60	180	7.70	1,227	13.40	5,693	19.40	13,040
4.70	200	7.80	1,276	13.60	5,888	19.60	13,340
4.80	220	7.90	1,324	13.80	6,084	19.80	13,620
4.90	240	8.00	1,373	14.00	6,280	20.00	13,900
5.00	260	8.20	1,480	14.20	6,484	20.20	14,240
5.10	285	8.40	1,587	14.40	6,688	20.40	14,580
5.20	309	8.60	1,700	14.60	6,894	20.60	14,920
5.30	334	8.80	1,820	14.80	7,102	20.80	15,260
5.40	358	9.00	1,940	[a] 15.00	7,310	21.00	15,600
5.50	383	9.20	2,074	15.20	7,522	21.50	16,500
5.60	412	9.40	2,208	15.40	7,734	22.00	17,400
5.70	441	9.60	2,348	15.60	7,950	22.50	18,350
5.80	469	9.80	2,495	15.80	8,170	23.00	19,300
5.90	498	10.00	2,642	16.00	8,390	23.50	20,300
6.00	527	10.20	2,797	16.20	8,666	24.00	21,300
6.10	562	10.40	2,952	16.40	8,942	24.50	22,350
6.20	596	10.60	3,112	16.60	9,204	25.00	23,400
6.30	631	10.80	3,276	16.80	9,452	25.50	24,500
6.40	665	11.00	3,440	17.00	9,700	26.00	25,600
6.50	700						

[a] Logarithmic extension above 15 feet.

daily discharge, in second-feet, of Esopus Creek at Kingston, N. Y., for 1904.

	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	955	868	808	3,320	2,170	368	620	130	138	224	406	389
.....	868	450	808	3,870	1,700	358	304	130	127	176	378	383
.....	608	707	848	2,740	1,400	469	230	123	128	160	353	397
.....	476	690	1,960	1,990	1,230	383	208	125	222	164	334	492
.....	608	641	1,220	1,710	1,070	335	190	108	200	130	321	[b]277
.....	608	616	1,020	1,590	946	334	184	113	174	130	339	257
.....	674	888	1,840	1,660	844	790	192	92	137	140	339	277
.....	649	3,710	([c])	1,890	753	620	190	95	125	127	297	257
.....	608	2,210	5,410	2,700	686	4,480	178	108	127	119	284	257
.....	641	1,680	3,710	3,360	638	3,570	157	112	128	123	284	180
.....	608	1,400	3,000	2,510	593	753	157	614	125	135	264	163
.....	529	1,300	2,310	1,960	548	1,330	152	270	92	147	256	146
.....	502	1,070	1,740	1,620	504	1,010	152	212	117	240	240	217
.....	516	1,020	1,480	1,370	475	819	133	184	150	236	469	197
.....	509	932	1,270	1,190	504	686	127	153	1,004	200	426	180
.....	476	868	1,050	1,140	1,030	593	123	147	716	168	418	237
.....	450	707	868	1,000	835	507	132	120	434	160	447	217
.....	410	658	955	945	742	443	178	137	341	180	389	217
.....	365	682	747	848	794	383	236	164	294	176	363	217
.....	365	649	1,270	790	1,110	358	176	274	240	160	346	237
.....	354	616	1,580	733	910	331	137	565	220	3,700	492	217
.....	436	1,090	1,390	669	1,210	299	120	368	196	6,120	665	197
.....	1,120	2,130	1,950	620	683	262	123	336	184	2,000	613	197
.....	2,900	1,400	2,450	586	634	285	115	292	178	1,600	589	237
.....	1,930	1,190	2,600	600	555	250	94	226	164	995	569	365
.....	1,460	888	6,920	733	565	210	143	226	160	831	512	297
.....	1,270	868	5,940	803	565	200	132	190	170	720	440	277
.....	1,030	838	3,030	2,350	455	198	132	174	164	613	527	[d]2,660
.....	978	828	2,070	3,910	406	200	107	155	160	534	504	2,050
.....	1,030	.....	1,590	2,530	386	204	224	150	200	484	527	1,510
.....	932	.....	1,520	.....	406	.....	162	138	.....	440	.....	1,240

[a] Record from January 1 to March 20 from ice curve.
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[c] Above rating table.
[d] Record approximate. Ice jam below bridge December 28 to 31.

Estimated monthly discharge of Esopus Creek at Kingston, N. Y., for 1904.

[Drainage area, 324.5 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	2,900	354	802	2.47	2.85
.....	3,710	450	1,089	3.36	3.62
30 days.....	6,920	747	2,112	6.51	7.26
.....	3,910	586	1,725	5.32	5.94
.....	2,170	386	818	2.52	2.91
.....	4,480	198	701	2.16	2.41
.....	620	94	178	.549	.633
.....	614	92	201	.619	.714
ber.....	1,004	92	227	.700	.781
.....	6,120	119	688	2.12	2.44
ber.....	665	240	413	1.27	1.42
ber.....	2,660	146	466	1.44	1.66

WAPPINGER CREEK NEAR WAPPINGER FALLS, N. Y.

This station was established at the first highway bridge crossing Wappinger Creek above the village of Wappinger Falls, May 19, 1903.

Observations of the stage of the stream on a graduated vertical scale attached to the central bridge pier are taken twice each day by Lee Jackson. Wappinger Creek is tributary to Hudson River. The drainage basin comprises a hilly plateau 400 to 600 feet above tide, nearly rectangular in shape, and including numerous small lakes and marsh areas. Winding branched tributaries gather the run-off from the numerous hills which dot the area. At a point about 16 miles from the mouth of the stream the basin becomes much narrower and the differences of elevation are of less magnitude. The stream flows near the right-hand side of a valley 3 to 4 miles in width, gradually descending to Wappinger Falls, where it makes a sudden descent to nearly tide-water level, the elevation of the Wappinger Pond being about 78 feet.[a]

Drainage areas of Wappinger Creek.

Location.	Area, place to place.	Total area, square miles.
East Branch of Wappinger Creek above Stanfordville	40.0	40.0
East Branch above junction with West Branch	67.4	107.4
West Branch above mouth	33.8	33.8
Total area of East and West branches	.....	141.2
Wappinger Creek above Van Wagner's	33.8	175.0
Wappinger Creek above Central Falls	14.7	189.7
Wappinger Creek above gaging station	4.78	194.4
Wappinger Creek above Wappinger Falls	7.81	202.2
Wappinger Creek above mouth	13.7	215.9

The bridge from which the gagings are made has two spans of 43.4 feet and 46.5 feet, respectively. The channel of the stream is sand and gravel, with some bowlders. The stream is straight for a distance of about 250 feet above the bridge and about 300 feet downstream from the bridge. The bench mark is a spike in the root of blazed tree, south side of road, 50 feet east of bridge. Assumed elevation is 100.00 feet. Elevation above datum plane of gage is 90.81 feet. But little power is developed on the stream. At Wappinger Falls a bleaching and dyeing establishment utilizes 22 feet fall.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

[a] The drainage basin is shown on the Poughkeepsie, Rhinebeck, Millbrook, and Clove sheets of the United States Geological Survey Topographic Atlas, from which the drainage area as given has been determined.

Discharge measurements of Wappinger Creek near Wappinger Falls, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 29	R. E. Horton	151	0.57	0.45	86
September 17	Covert and Swancott	325	1.35	2.04	438

Mean daily gage height, in feet, of Wappinger Creek near Wappinger Falls, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.20	3.70	2.90	2.75	2.00	1.15	2.20	0.45	−0.10	0.90	0.90	1.00
2	2.20	3.70	2.75	3.20	1.80	1.00	1.55	.15	− .10	.92	.88	1.22
3	2.20	3.70	4.20	2.85	1.55	.95	1.10	.15	− .05	.80	.85	1.30
4	.....	3.70	6.95	2.55	1.50	.95	.85	.15	− .05	.75	.82	1.40
5	.....	3.70	5.00	2.20	1.45	.95	.85	.15	.00	.72	.80	1.38
6	.....	2.80	3.70	2.00	1.35	1.55	1.10	.15	− .05	.70	.80	1.35
7	.....	3.45	3.65	2.05	1.25	1.55	.80	.15	− .05	.65	.80	1.30
8	.....	4.85	8.60	2.05	1.15	1.40	.65	.15	.05	.62	.78	1.30
9	2.20	3.30	7.65	2.05	1.15	4.75	.55	.10	− .05	.60	.75	1.30
10	2.20	3.10	7.05	2.05	1.05	3.95	.55	.15	.10	.58	.72	1.30
11	.....	3.10	6.30	2.05	1.05	3.10	.60	.45	.15	.52	.70	1.30
12	.....	3.10	4.70	1.95	.95	2.25	.65	.90	.05	1.00	.70	1.30
13	.....	3.10	4.65	1.90	.90	1.90	.60	.60	− .05	1.42	.70	1.30
14	.....	3.10	2.95	1.80	.85	1.65	.50	.45	.85	1.15	1.00	1.30
15	.....	3.10	1.75	1.75	.85	1.50	.45	.25	3.00	.95	1.30	1.30
16	2.20	3.10	1.55	1.65	.85	1.30	.45	.15	2.85	.78	1.22	1.30
17	2.20	3.10	1.45	1.65	1.05	1.15	.45	.15	1.95	.75	1.18	1.30
18	2.20	3.10	1.45	1.55	1.20	1.00	.80	.15	1.48	.72	1.12	1.30
19	2.20	3.10	1.55	1.40	1.20	.95	1.20	.15	1.28	.70	.95	1.30
20	2.20	3.10	2.65	1.35	1.15	.85	.70	.25	1.08	.65	.90	1.30
21	2.20	3.10	2.40	1.25	1.05	.85	.55	.25	1.00	1.75	.82	1.30
22	2.20	3.20	2.10	1.15	.95	.75	.50	.40	.85	2.95	.72	1.30
23	2.40	4.45	2.55	1.05	.90	.70	.45	.15	.78	2.20	.65	1.30
24	5.15	4.20	2.70	1.05	.85	.65	.45	− .25	.72	1.72	.60	1.30
25	4.10	3.45	2.50	1.05	.85	.65	.43	− .20	1.12	1.52	.78	1.40
26	3.75	2.95	2.55	1.10	1.40	.65	.35	.10	1.25	1.42	.98	1.30
27	3.70	2.80	2.70	1.15	2.95	.55	.35	.05	1.18	1.38	.90	1.58
28	3.70	2.90	2.30	2.90	2.00	.50	.35	.05	1.00	1.25	1.22	4.40
29	3.70	3.30	1.85	2.85	1.25	.60	.35	.05	.98	1.12	1.25	4.05
30	3.30	.....	1.95	2.35	1.25	.90	.35	− .05	.95	1.00	1.18	3.50
31	3.70	.....	1.95	.....	1.35	.....	.45	.00	.....	.95	.....	3.20

CROTON RIVER AT OLD CROTON DAM, NEW YORK.

Croton River drains an area of rough, irregular topography situated east of Hudson River, to which it is tributary at Croton Landing. A gaging record has been maintained, beginning January, 1868, at the old Croton dam. The record includes the amount wasted over the dam and the diversion to New York City for municipal supply through Croton aqueduct.[a] The following table shows the monthly mean dis-

[a] Full description of methods of gaging, and results for the years 1868 to 1899, inclusive, may be found in Supplement, State Engineer's Report for 1902. Report on Gagings of the Volume of Discharge of Streams, *by Robert E. Horton, hydrographer*, pp. 290-299, inclusive.

charge at the Croton dam from July, 1901, to September, 1903, inclusive. The data given has been deduced from a table of yield in gallons per square mile per day, given in Report of New York Water Supply Commission, page 220. The drainage area above the old Croton dam is 338.8 square miles, comprising 3.6 per cent water surface.

Estimated monthly discharge of Croton River at old Croton dam, New York, 1901-1903.

[Drainage area, 339 square miles.]

Month.	Mean discharge in second-feet.	Gallons per square mile per day.	Run-off.	
			Second-feet per square mile.	Depth in inches.
1901.				
July	393	749,000	1.16	1.34
August	1,119	2,131,000	3.30	3.80
September	644	1,232,000	1.90	2.12
October	752	1,432,000	2.22	2.56
November	359	685,000	1.06	1.18
December	1,308	2,491,000	3.86	4.45
1902.				
January	1,166	2,223,000	3.44	3.97
February	803	1,529,000	2.37	2.47
March	2,962	5,638,000	8.74	10.08
April	922	1,759,000	2.72	3.03
May	515	982,000	1.52	1.75
June	241	458,000	.711	.793
July	220	422,000	.649	.748
August	183	352,000	.540	.623
September	170	322,000	.501	.559
October	654	1,246,000	1.93	2.22
November	451	860,000	1.33	1.48
December	1,484	2,827,000	4.38	5.05
The year			2.40	32.77
1903.				
January	1,050	1,998,000	3.10	3.57
February	1,156	2,202,000	3.41	3.54
March	1,776	3,380,000	5.24	6.04
April	1,027	1,957,000	3.03	3.38
May	210	399,000	.619	.714
June	956	1,818,000	2.82	3.15
July	454	867,000	1.34	1.54
August	454	867,000	1.34	1.54
September	549	1,051,000	1.62	1.81

ISCELLANEOUS MEASUREMENTS IN HUDSON RIVER DRAINAGE BASIN.

The following miscellaneous measurements were made in the Hud- n River drainage basin during 1904, by R. E. Horton.

Miscellaneous measurements in Hudson River drainage basin.

Date.	Stream.	Locality.	Gage height.	Discharge.
			Feet.	*Second-feet.*
ay 18	Nine Mile Creek	Powell Bridge near Oriskany, N. Y.	[a] 21.04	39
ptember 13	do	do	[a] 22.17	20
gust 25	Champlain Canal feeder.	Glen Falls, N. Y.	[b] 9.57	302

[a] Distance of water surface below the top of the outer downstream tie bar, 15 feet from the left end the bridge.
[b] Distance of water surface below the top stone of the bridge seat at the left end, downstream e.

PASSAIC RIVER DRAINAGE BASIN.

Passaic River rises in Somerset and Morris counties, N. J. Above s confluence with Pompton River, its main tributary, it meanders rough a flat country of Triassic red sandstone, to which in large easure must be attributed the turbidity of its waters. In contrast ith the sluggish, muddy character of the Passaic, the Pompton is a pid stream and its waters are clear. It drains parts of Sussex, Pas- ic, and Morris counties, and traverses for a large part of its course country of hard, crystalline rocks and heavy forests, the general vel of which is several hundred feet above that of the Passaic. At eir confluence the Pompton enters with a current which carries it ll toward the right bank of the Passaic, and at times of flood uses much backwater in the latter.

The flow of Passaic River is of special interest from the fact that veral large cities in its drainage basin take their public water supply om it, and because of the valuable water-power privileges along its urse, particularly at the city of Paterson. Several cities, including terson and Passaic, throw their sewage into this stream, and in the wer part of its course it becomes so polluted as to be offensive to operty holders along its banks and to seriously interfere with the mfort and health of the inhabitants of several towns.

The highest recorded flood which has occurred on this drainage sin was that of October, 1903. The estimated discharge at Dundee m was 35,800 second-feet. This flood is fully described in Water- pply Paper No. 92. The flood began at 6.30 p. m. October 8, 1903, d lasted until midnight October 18, 1903, the maximum height being ached at 9 p. m. October 10, 1903. There was a total rainfall of 1.74 inches in thirty-six hours.

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The United States Geological Survey maintained gaging stations in this issue in 1904 as follows: Passaic River at Millington, N. J.; Passaic River near Chatham, N. J.; Pompton River at Pompton Plains, N. J.; Ramapo River near Mahwah, N. J.; Wanaque River near Wanaque, N. J.; Rockaway River near Boonton, N. J.

Est

PASSAIC RIVER AT MILLINGTON, N. J.

This station was established November 25, 1903, by F. H. Tillinghast. It is located at the lower highway bridge at Millington, N. J. The standard boxed chain gage is fastened to the wooden hand rail on the downstream side of the bridge. The pulley wheel is located at a point 24 feet from the right abutment. The length of the chain from the end of the weight to the marker is 14.17 feet. Bench mark No. 1 is a square chisel draft on the corner of the right abutment at the downstream side. Its elevation is 11.82 feet above gage datum. Bench mark No. 2 is the top of a nail 2 feet from the ground in an elm tree 150 feet east of the bridge. Its elevation is 13.57 feet above gage datum. Bench mark No. 3 is the top of the circular iron bridge chord or tension bar directly under the pulley. Its elevation is 8.97 feet above gage datum. Bench mark No. 4 is the top of the wooden rail of the bridge at the pulley. Its elevation is 13.44 feet above gage datum. Discharge measurements are made from the downstream side of the old wooden truss bridge, to which the gage is attached. The bridge has a span of 69.7 feet. The initial point for soundings is the vertical face of the right abutment on the downstream side. The channel is straight for 600 feet above and 200 feet below the station. The current has a moderate velocity. Both banks are high, without trees and are not subject to overflow. The bed of the stream is composed of gravel, with a few scattered bowlders, and is permanent. The section is shallow. There is but one channel at all stages. The gage is read twice each day by Mary I. Bray.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Passaic River at Millington, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sc. feet.*
April 9	F. H. Tillinghast	65	90	1.48	2.12	133.
May 13	F. H. Brundage	57	37.2	1.02	1.36	37.8
June 4	J. C. Hoyt	63	63.	1.19	1.65	75.
August 1	do	55	27.	.77	1.20	21.
November 9	H. D. Comstock	62	44.	.88	1.42	38.

an daily gage height, in feet, of Passaic River at Millington, N. J., for 1904.

th.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	2.22	2.60	3.00	3.45	2.30	1.95	1.25	1.28	1.25	1.30	1.60	1.42
.....	2.15	2.55	2.92	4.00	2.45	1.82	1.15	1.58	1.20	1.30	1.50	1.35
.....	2.15	2.50	3.00	3.50	2.20	1.78	1.10	1.85	1.20	1.30	1.48	1.32
.....	2.12	2.50	3.45	2.90	2.02	1.60	1.10	1.58	1.20	1.30	1.52	1.25
.....	2.10	2.45	3.18	2.52	1.88	1.60	1.03	1.60	1.20	1.30	1.48	1.88
.....	2.08	2.42	2.98	2.28	1.72	1.62	1.10	2.05	1.12	1.30	1.42	1.88
.....	2.05	2.45	3.90	2.20	1.68	1.65	1.20	2.00	1.10	1.25	1.40	1.58
.....	2.00	2.98	7.18	2.12	1.65	1.68	1.65	1.95	1.18	1.20	1.40	1.52
.....	2.00	2.90	6.05	2.15	1.55	1.65	1.72	1.98	1.12	1.35	1.40	1.40
.....	2.00	2.65	3.95	2.35	1.50	1.62	1.38	1.90	1.12	1.32	1.40	1.38
.....	2.00	2.60	2.62	2.25	1.52	1.52	1.35	2.52	1.10	1.30	1.52	1.40
.....	2.00	2.55	2.28	2.08	1.45	1.38	1.28	2.58	1.10	1.72	1.52	1.48
.....	2.00	2.50	2.18	2.00	1.35	1.32	1.38	2.40	1.10	1.90	1.70	1.50
.....	2.15	2.45	2.08	1.90	1.40	1.25	1.22	2.12	1.60	1.85	2.42	1.50
.....	2.15	2.42	1.98	1.78	1.52	1.28	1.15	1.88	4.92	1.68	2.45	1.50
.....	2.15	2.40	1.95	1.70	1.48	1.22	1.12	1.65	4.80	1.55	2.22	1.52
.....	2.15	2.35	1.90	1.60	1.45	1.20	1.08	1.52	4.30	1.42	2.10	1.55
.....	2.15	2.35	1.90	1.60	1.42	1.20	1.20	1.40	3.75	1.40	1.92	1.65
.....	2.15	2.35	2.25	1.60	1.45	1.20	1.25	1.35	3.25	1.40	1.78	1.65
.....	2.12	2.35	3.00	1.55	1.55	1.18	1.15	2.32	2.80	1.40	1.70	1.65
.....	2.10	2.35	2.82	1.55	1.38	1.15	1.15	2.75	2.40	2.35	1.68	1.65
.....	2.15	5.92	2.75	1.50	1.38	1.15	1.08	2.60	2.08	4.05	1.60	1.65
.....	4.78	6.72	3.05	1.50	1.30	1.10	1.08	2.40	1.80	3.40	1.52	1.68
.....	5.90	6.45	2.98	1.40	1.30	1.10	1.08	2.25	1.62	3.10	1.50	1.70
.....	5.00	5.12	2.85	1.42	1.30	1.05	1.12	1.95	1.58	2.72	1.50	1.78
.....	3.88	3.50	2.75	1.42	1.30	1.05	1.10	1.65	1.50	2.40	1.45	1.90
.....	2.80	2.75	2.78	1.75	1.15	1.10	1.10	1.48	1.45	2.18	1.40	1.95
.....	2.68	2.82	2.51	2.45	1.18	1.10	1.10	1.40	1.42	1.92	1.65	2.18
.....	2.65	3.35	2.35	2.55	1.20	1.12	1.52	1.32	1.35	1.80	1.60	2.28
.....	2.65	.....	2.20	2.45	1.22	1.20	1.45	1.30	1.40	1.72	1.38	2.25
.....	2.60	.....	2.38	.....	1.90	.....	1.25	1.25	.....	1.68	.....	2.25

–River frozen from January 1 to March 8. February 22, highest reading, 7.00; March 8, reading, 7.50.
; the frozen period the gage heights are to the surface of the ice.

The United States Geological Survey maintained gaging stations in this basin in 1904 as follows: Passaic River at Millington, N. J.; Passaic River near Chatham, N. J.; Pompton River at Pompton Plains, N. J.; Ramapo River near Mahwah, N. J.; Wanaque River near Wanaque, N. J.; Rockaway River near Boonton, N. J.

PASSAIC RIVER AT MILLINGTON, N. J.

This station was established November 25, 1903, by F. H. Tillinghast. It is located at the lower highway bridge at Millington, N. J. The standard boxed chain gage is fastened to the wooden hand rail on the downstream side of the bridge. The pulley wheel is located at a point 24 feet from the right abutment. The length of the chain from the end of the weight to the marker is 14.17 feet. Bench mark No. 1 is a square chisel draft on the corner of the right abutment at the downstream side. Its elevation is 11.82 feet above gage datum. Bench mark No. 2 is the top of a nail 2 feet from the ground in an elm tree 150 feet east of the bridge. Its elevation is 13.57 feet above gage datum. Bench mark No. 3 is the top of the circular iron bridge chord or tension bar directly under the pulley. Its elevation is 8.97 feet above gage datum. Bench mark No. 4 is the top of the wooden rail of the bridge at the pulley. Its elevation is 13.44 feet above gage datum. Discharge measurements are made from the downstream side of the old wooden truss bridge, to which the gage is attached. The bridge has a span of 69.7 feet. The initial point for soundings is the vertical face of the right abutment on the downstream side. The channel is straight for 600 feet above and 200 feet below the station. The current has a moderate velocity. Both banks are high, without trees and are not subject to overflow. The bed of the stream is composed of gravel, with a few scattered bowlders, and is permanent. The section is shallow. There is but one channel at all stages. The gage is read twice each day by Mary I. Bray.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Passaic River at Millington, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 9	F. H. Tillinghast	65	90	1.48	2.12	133.
May 13	F. H. Brundage	57	37.2	1.02	1.36	37.8
June 4	J. C. Hoyt	63	63.	1.19	1.65	75.
August 1	do	55	27.	.77	1.20	21.
November 9	H. D. Comstock	62	44.	.88	1.42	38.

Mean daily gage height, in feet, of Passaic River at Millington, N. J., for 1904.

Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.22	2.60	3.00	3.45	2.30	1.95	1.25	1.28	1.25	1.30	1.60	1.42
2	2.15	2.55	2.92	4.00	2.45	1.82	1.15	1.58	1.20	1.30	1.50	1.35
3	2.15	2.50	3.00	3.50	2.20	1.78	1.10	1.85	1.20	1.30	1.48	1.32
4	2.12	2.50	3.45	2.90	2.02	1.60	1.10	1.58	1.20	1.30	1.52	1.25
5	2.10	2.45	3.18	2.52	1.88	1.60	1.03	1.60	1.20	1.30	1.48	1.88
6	2.08	2.42	2.98	2.28	1.72	1.62	1.10	2.05	1.12	1.30	1.42	1.88
7	2.05	2.45	3.90	2.20	1.68	1.65	1.20	2.00	1.10	1.25	1.40	1.58
8	2.00	2.98	7.18	2.12	1.65	1.68	1.65	1.95	1.18	1.20	1.40	1.52
9	2.00	2.90	6.05	2.15	1.55	1.65	1.72	1.98	1.12	1.35	1.40	1.40
10	2.00	2.65	3.95	2.35	1.50	1.62	1.38	1.90	1.12	1.32	1.40	1.38
11	2.00	2.60	2.62	2.25	1.52	1.52	1.35	2.52	1.10	1.30	1.52	1.40
12	2.00	2.55	2.28	2.08	1.45	1.38	1.28	2.58	1.10	1.72	1.52	1.48
13	2.00	2.50	2.18	2.00	1.35	1.32	1.38	2.40	1.10	1.90	1.70	1.50
14	2.15	2.45	2.08	1.90	1.40	1.25	1.22	2.12	1.60	1.85	2.42	1.50
15	2.15	2.42	1.98	1.78	1.52	1.28	1.15	1.88	4.92	1.68	2.45	1.50
16	2.15	2.40	1.95	1.70	1.48	1.22	1.12	1.65	4.80	1.55	2.22	1.52
17	2.15	2.35	1.90	1.60	1.45	1.20	1.08	1.52	4.30	1.42	2.10	1.55
18	2.15	2.35	1.90	1.60	1.42	1.20	1.20	1.40	3.75	1.40	1.92	1.65
19	2.15	2.35	2.25	1.60	1.45	1.20	1.25	1.35	3.25	1.40	1.78	1.65
20	2.12	2.35	3.00	1.55	1.55	1.18	1.15	2.32	2.80	1.40	1.70	1.65
21	2.10	2.35	2.82	1.55	1.38	1.15	1.15	2.75	2.40	2.35	1.68	1.65
22	2.15	5.92	2.75	1.50	1.38	1.15	1.08	2.60	2.08	4.05	1.60	1.65
23	4.78	6.72	3.05	1.50	1.30	1.10	1.08	2.40	1.80	3.40	1.52	1.68
24	5.90	6.45	2.98	1.40	1.30	1.10	1.08	2.25	1.62	3.10	1.50	1.70
25	5.00	5.12	2.85	1.42	1.30	1.05	1.12	1.95	1.58	2.72	1.50	1.78
26	3.88	3.50	2.75	1.42	1.30	1.05	1.10	1.65	1.50	2.40	1.45	1.90
27	2.80	2.75	2.78	1.75	1.15	1.10	1.10	1.48	1.45	2.18	1.40	1.95
28	2.68	2.82	2.51	2.45	1.18	1.10	1.10	1.40	1.42	1.92	1.65	2.18
29	2.65	3.35	2.35	2.55	1.20	1.12	1.52	1.32	1.35	1.80	1.60	2.28
30	2.65	.....	2.20	2.45	1.22	1.20	1.45	1.30	1.40	1.72	1.38	2.25
31	2.60	.....	2.38	.....	1.90	.....	1.25	1.25	.....	1.68	.....	2.25

NOTE.—River frozen from January 1 to March 8. February 22, highest reading, 7.00; March 8, highest reading, 7.50.
During the frozen period the gage heights are to the surface of the ice.

PASSAIC RIVER NEAR CHATHAM, N. J.

This station was established February 10, 1903, by the United States Weather Bureau, by which it is maintained. It is located at the second bridge, about 1½ miles upstream from Chatham, N. J. The original gage consists of a 2 by 12 inch board spiked to the upstream wing wall of the right abutment. On December 12, 1903, a standard chain gage was installed on the downstream side of the bridge; the length of the chain from the end of the weight to the marker is 15.59 feet. Bench mark No. 1 for the new gage is the corner of the top of the right abutment on the upstream side. Its elevation is 10.31 feet above the datum of the chain gage. Bench mark No. 2 is the upper surface of the upper chord directly over the gage pulley. Its elevation is 17.91 feet above gage datum. Bench mark No. 3 is the upper surface of the lower chord directly under the pulley. Its elevation is 9.19 feet above gage datum. Bench mark No. 4 is the top of the first bolt on the coping of the downstream wing wall, right hand abutment. Its elevation is 10.64 feet above gage datum. Discharge measurements are made from the single-span steel highway bridge, to which the gage is attached. The downstream side is marked every 5 feet. The initial point for soundings is the base of the right abutment. The channel is straight for 400 feet above and below the station and the current swift. At low water the current makes a small angle with the normal to the cross section, caused by a small island just below the bridge. Two hundred feet above the bridge is an old timber dam partly washed away. Both banks are high and wooded, and are not liable to overflow. The bed of the stream is composed of gravel, with occasional bowlders. The gage reader for the Weather Bureau is M. A. Butler.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements on Passaic River near Chatham, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 9	F. H. Tillinghast	66	146	1.61	3.25	23[illegible]
May 14	F. H. Brundage	64	80	.65	2.52	5[illegible]
June 4	J. C. Hoyt	70	106	.96	2.80	10[illegible]
August 1	do	70	76	.43	2.40	3[illegible]
November 9	H. D. Comstock	70	92	.63	2.61	5[illegible]

Mean daily gage height, in feet, of Passaic River near Chatham, N. J., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 3.00	3.80	5.60	3.90	3.40	3.00	2.10	2.40	2.40	2.50	2.70	2.40
2	2.70	3.60	5.20	4.70	3.50	3.00	2.10	2.50	2.40	2.50	2.70	2.40
3	2.70	3.40	4.70	4.50	3.40	2.90	2.10	3.20	2.40	2.40	2.60	2.40
4	2.70	([a])	6.00	4.10	3.20	2.80	2.10	3.40	2.30	2.40	2.60	2.40
5	2.70	([a])	5.90	3.70	3.10	2.70	2.10	3.10	2.30	2.40	2.50	2.30
6	2.70	3.40	5.20	3.40	2.90	2.70	2.10	4.40	2.30	2.40	2.50	2.30
7	2.70	3.70	4.60	3.30	3.80	2.80	2.20	4.20	2.30	2.30	2.50	2.30
8	2.70	5.50	6.80	3.30	2.80	2.70	2.70	3.70	2.22	2.30	2.50	2.30
9	2.70	5.10	6.00	3.30	2.70	2.80	3.10	3.30	2.22	2.30	2.60	([a])
10	2.70	([a])	5.60	3.50	2.70	2.70	3.00	3.00	2.22	2.30	2.60	([a])
11	2.70	([a])	[b] 5.00	3.30	2.70	2.60	2.80	4.60	2.20	2.30	2.70	([a])
12	2.70	([a])	4.00	3.30	2.60	2.60	2.60	4.20	2.20	2.70	2.90	([a])
13	3.10	([a])	3.50	3.20	2.60	2.50	2.40	3.90	2.10	3.50	3.20	([a])
14	3.50	([a])	3.40	3.00	2.50	2.40	2.50	3.50	2.10	3.30	3.80	([a])
15	3.40	([a])	3.30	2.90	2.60	2.40	2.40	3.20	6.00	2.90	3.70	([a])
16	3.20	([a])	3.20	2.90	2.80	2.30	2.30	3.00	5.50	2.80	3.50	([a])
17	3.00	([a])	3.00	2.80	2.70	2.30	2.30	2.80	5.20	2.80	3.10	([a])
18	3.00	([a])	3.00	2.80	2.60	2.30	2.40	2.50	5.00	2.70	3.00	([a])
19	3.00	([a])	3.50	2.70	2.60	2.30	2.50	2.30	4.30	2.70	2.90	([a])
20	3.00	([a])	3.70	2.70	2.70	2.20	2.40	2.70	4.20	2.60	2.90	([a])
21	3.20	([a])	3.40	2.70	2.80	2.20	2.30	4.00	3.60	2.60	2.80	([a])
22	4.00	6.70	3.70	2.60	2.70	2.20	2.30	3.90	3.40	4.60	2.80	([a])
23	[c] 4.50	7.50	3.90	2.60	2.60	2.20	2.30	3.70	3.00	4.50	2.70	2.50
24	7.60	[c] 7.90	3.90	2.60	2.40	2.20	2.30	3.50	2.90	4.30	2.70	2.70
25	7.20	7.60	3.70	2.60	2.40	2.10	2.30	3.20	2.80	3.90	2.70	([a])
26	6.70	7.50	3.60	2.60	2.40	2.10	2.30	3.00	2.70	3.60	2.70	([a])
27	6.10	6.50	3.60	2.80	2.30	2.10	2.30	2.70	2.70	3.20	2.60	([a])
28	5.00	5.60	3.50	4.00	2.30	2.10	2.20	2.60	2.60	3.00	2.50	3.50
29	4.50	5.70	3.40	3.90	2.30	2.10	2.60	2.50	2.50	2.90	2.50	4.00
30	4.00	.....	3.30	3.50	2.30	2.10	2.70	2.50	2.50	2.80	2.50	3.60
31	3.90	.....	3.20	.....	2.60	.....	2.60	2.40	.....	2.70	.....	3.30

[a] River frozen January 1 to March 10, inclusive; also December 9–22 and December 25–27, inclusive. Gage heights to surface of ice.
[b] River clear.
[c] Ice jam.

POMPTON RIVER AT POMPTON PLAINS, N. J.

This station measures the combined flow of Pequannock, Wanaque, Ramapo, and Pompton rivers. It was established March 7, 1903, by the United States Weather Bureau, by which it is maintained. It is located at a 254-foot timber dam situated about half a mile east of Pompton Plains railroad station. The dam constitutes a portion of the headworks of the Morris canal feeder at Pompton Plains. A cast-iron gage is bolted vertically to the framework of the lock gates at the entrance to the canal. The gage reader for the Weather Bureau is E. M. Le Fevre, who reads the gage every morning. The main portion and crest of the dam is timber 6 inches in width. The downstream face is vertical, and 2.7 feet below the crest is an apron. The upstream side of the dam is paved. Starting at a point 6 inches below the crest of the dam, the paving is placed downward and upstream at a slope of 6 inches in 3 feet. The rating table for this dam was constructed as follows: The Francis formula was used, modified by comparison with results of experiments made at Cornell University. The coefficients used were those derived from United States Geological Survey experiments, Cornell series 40, for a 6-inch broad-crested weir. This gives a varying coefficient for low heads up to a depth of 0.8 foot, at which height the nappe breaks clear from the horizontal face and the weir becomes practically sharp crested, giving the Francis formula, $Q=3.33\,lh^{\frac{3}{2}}$. The crest of the dam is slightly irregular, and in order to apply the weir formula to it an accurate profile was taken and the dam was divided into a number of approximately level sections. These sections comprised all elevations between certain limiting values, whether in juxtaposition or not. Each section was computed separately for all gage heights. By combining these the flow on the entire dam, which is 254.5 feet long, was obtained for each gage reading. The rating table shows the combined discharge of all sections for the same gage heights. To the flow over the dam must be added the flow through the Morris canal feeder, records of which are maintained. All the water in times of flood passes over the dam, except in very extreme cases, as the flood of October, 1903. Bench mark No. 1 is a square chiseled on the coping of the left upstream parapet wall of the head-gates to the feeder canal. Its elevation is 11.99 feet above gage datum. Bench mark No. 2 is a square chiseled on the outside edge of the upstream parapet wall at the entrance to the feeder. Its elevation is 12.10 feet above the zero of the cast-iron gage. This station was discontinued December 31, 1904.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Mean daily gage height, in feet, of Pompton River at Pompton Plains, N. J., for 1904.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.90	.....	4.60	4.80	3.70	3.80	4.10	4.40	4.40
2	.....	5.50	.....	4.60	4.50	3.70	3.80	4.10	4.30	4.40
3	.....	5.20	.....	4.60	4.20	3.70	3.80	4.10	4.20	4.40
4	.....	5.00	.....	4.50	4.10	3.70	3.80	4.10	4.10	4.40
5	.....	.....	.....	4.50	4.00	3.70	3.80	4.10	4.00	4.40
6	.....	.....	.....	4.50	4.00	3.70	3.80	4.10	4.10	4.40
7	.....	.....	.....	4.40	4.00	3.70	3.80	4.10	4.10	4.40
8	7.50	.....	.....	4.40	4.00	3.70	3.80	4.10	4.10	4.40
9	6.40	.....	.....	4.80	4.20	3.70	3.80	4.10	4.10	4.40
10	5.80	.....	.....	4.80	4.00	3.70	3.90	4.10	4.10	4.40
11	5.20	.....	.....	4.50	4.00	3.90	3.90	4.10	4.10	4.40
12	4.80	.....	.....	4.40	4.00	3.80	3.90	4.10	4.10	4.40
13	.....	.....	.....	4.30	4.00	3.70	3.90	4.30	4.10	4.40
14	.....	.....	.....	4.30	4.00	3.70	3.90	4.10	4.70	4.40
15	.....	.....	.....	4.30	4.00	3.70	5.50	4.10	4.60	4.40
16	.....	.....	.....	4.20	4.00	3.70	5.00	4.10	4.50	4.40
17	.....	.....	.....	4.10	4.00	3.70	4.70	4.10	4.40	4.40
18	.....	.....	4.40	4.10	3.90	3.60	4.30	4.10	4.40	4.40
19	.....	.....	4.30	4.10	3.80	3.60	4.30	4.10	4.40	4.40
20	.....	.....	4.40	4.10	3.80	3.60	4.30	4.10	4.30	4.40
21	.....	.....	4.30	4.00	3.80	4.30	4.30	4.10	4.30	4.40
22	.....	.....	4.20	4.00	3.70	4.30	4.30	5.70	4.40	4.40
23	.....	.....	4.20	4.00	3.70	4.20	4.30	5.00	4.40	4.40
24	.....	.....	4.20	4.00	3.70	4.00	4.20	4.80	4.40	4.40
25	.....	.....	4.20	4.00	3.70	4.00	4.10	4.70	4.40	.....
26	.....	.....	4.30	3.90	3.70	3.90	4.10	4.60	4.40	.....
27	.....	.....	4.30	4.00	3.70	3.80	4.10	4.60	4.40	.....
28	.....	.....	4.30	4.00	3.70	3.80	4.10	4.60	4.40	4.70
29	.....	5.10	4.20	4.00	3.70	3.80	4.10	4.60	4.40	4.60
30	.....	4.90	4.20	4.00	3.80	3.80	4.10	4.50	4.40	4.50
31	4.90	.....	4.40	.....	3.70	3.80	.....	4.40	.....	4.50

NOTE.—Gage broken from January 1 to March 7, from March 13–30, from April 5–28, and from May 1–17. River frozen December 25 to 27, inclusive.

RAMAPO RIVER NEAR MAHWAH, N. J.

This station was established February 10, 1903, by the United States Weather Bureau, by which it is maintained. It is located at a concrete-arch highway bridge about 1 mile west of Mahwah, N. J. A standard chain gage is bolted to the hand rail on the downstream side of the bridge. The length of the chain from the end of the weight to the marker is 20.65 feet. Bench mark No. 1 is a square chiseled on the coping of the upstream parapet wall at the left bank. Its elevation is 17.72 feet above gage datum. Bench mark No. 2 is a square chiseled on the edge of the coping, 3.5 feet west of the gage pulley. Its elevation is 17.43 feet above gage datum. The gage reader for the Weather Bureau is M. F. Brooks. Discharge measurements are made from the upstream side of the concrete-arch highway bridge to which the gage is attached. The bridge has a single span of 68 feet between abutments. The initial point for soundings is the end post of the hand rail on the left bank. The channel is straight for 300 feet above and 200 feet below the bridge. The current is swift. About 200 feet

below the bridge there is a rift with about 1 foot fall. The right bank is low, and during high water the lowlands on this side of the river are flooded. The left bank is high, wooded, and not liable to overflow. The bed of the stream is composed of gravel and scattered bowlders, and there is but one channel.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Ramapo River near Mahwah, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 2	F. H. Tillinghast	64	363	3.61	6.00	1,309
May 18	F. H. Brundage	57	210	.88	3.62	185
June 3	J. C. Hoyt	55	250	1.24	4.02	310
August 2	do	45	166	.16	2.65	27
November 11	Murphy and Comstock.	51	191	.48	3.26	92

Mean daily gage height, in feet, of Ramapo River near Mahwah, N. J., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.10	4.10	4.10	4.80	4.60	4.20	5.30	2.70	2.60	3.00	3.50	3.50
2	4.00	4.00	4.00	5.90	4.40	4.40	4.30	2.70	2.50	3.00	3.50	3.40
3	[b]4.00	4.00	4.00	5.30	4.20	4.40	3.80	2.90	2.60	3.00	3.50	3.40
4	[b]4.00	4.00	5.10	4.90	4.10	4.00	3.40	2.80	2.50	2.90	3.40	3.40
5	[b]4.00	.....	4.70	4.60	4.00	3.90	3.30	2.80	2.50	2.90	3.40	3.40
6	[b]3.90	4.00	4.20	4.50	3.90	3.70	3.20	2.80	2.50	2.80	3.50	3.30
7	[b]3.90	4.00	4.20	4.40	3.90	3.60	3.10	2.80	2.50	2.70	3.50	3.30
8	[b]3.90	4.20	7.10	4.40	3.80	3.60	3.40	2.80	2.50	2.70	3.40	3.30
9	[b]3.90	4.50	6.40	4.30	3.80	4.30	3.30	2.80	2.50	2.80	3.40	3.30
10	.....	4.50	5.40	4.70	3.70	4.50	3.10	2.70	2.90	2.80	3.40	3.30
11	.....	4.50	5.10	4.50	3.70	4.10	3.10	2.80	2.70	2.80	3.40	3.20
12	.....	4.20	4.90	4.40	3.70	3.80	3.10	2.90	2.60	2.80	3.40	3.20
13	.....	4.00	4.70	4.40	3.60	3.60	3.00	2.80	2.60	3.60	3.40	3.20
14	.....	3.80	4.50	4.20	3.60	3.50	2.90	2.80	2.50	3.40	4.00	3.20
15	.....	3.80	4.80	4.20	3.60	3.50	2.90	2.80	5.70	3.20	3.80	3.20
16	.....	.....	4.20	4.10	4.10	3.40	2.90	2.80	5.80	3.10	3.80	3.20
17	[b]3.80	.....	4.10	4.00	3.90	3.30	2.80	2.70	4.30	3.10	3.80	3.20
18	[b]3.80	.....	4.10	4.00	3.80	3.30	2.80	2.70	3.70	3.00	3.70	3.20
19	[b]3.80	3.70	4.10	3.90	3.70	3.20	3.00	2.70	3.50	2.90	3.70	([c])
20	[b]3.80	3.70	4.70	3.80	3.70	3.20	2.90	2.70	3.30	2.90	3.70	([c])
21	[b]4.00	([d])	4.70	3.80	3.60	3.00	2.80	3.50	3.30	3.00	3.70	([c])
22	[b]4.20	5.20	4.50	4.80	3.50	3.00	2.70	3.60	3.20	6.90	3.95	([c])
23	5.00	5.60	4.60	4.70	3.50	3.00	2.70	3.30	3.20	5.80	4.00	([c])
24	5.90	5.20	4.80	3.70	3.40	2.90	2.70	3.00	3.10	4.70	3.90	3.40
25	4.80	5.00	4.80	3.70	3.30	2.80	2.80	2.90	3.10	4.30	3.80	3.60
26	4.60	4.50	4.70	3.70	3.50	2.80	2.90	2.80	3.10	4.10	3.70	3.60
27	4.40	4.40	5.10	3.70	3.60	2.80	2.80	2.70	3.10	4.00	3.60	.....
28	4.40	4.10	4.70	4.60	3.60	2.80	2.80	2.70	3.10	3.80	3.60	4.10
29	4.40	4.30	4.50	5.30	3.40	2.80	3.00	2.70	3.00	3.70	3.60	4.60
30	4.40	.....	4.40	4.90	3.40	2.90	2.90	2.90	3.00	3.70	3.60	4.40
31	4.20	.....	4.40	.....	4.10	.....	2.80	2.80	.....	3.60	.....	4.10

[a] River frozen January 1 to February 29. [b] Gage heights estimated. [c] River frozen. [d] Ice 2 feet.

Rating table for Ramapo River near Mahwah, N. J., from January 1, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.50	11	3.70	230	4.90	565	6.10	1,380
2.60	25	3.80	250	5.00	610	6.20	1,480
2.70	40	3.90	270	5.10	660	6.30	1,580
2.80	56	4.00	295	5.20	715	6.40	1,680
2.90	73	4.10	320	5.30	775	6.50	1,780
3.00	91	4.20	345	5.40	835	6.60	1,880
3.10	110	4.30	370	5.50	900	6.70	1,980
3.20	130	4.40	395	5.60	970	6.80	2,080
3.30	150	4.50	425	5.70	1,045	6.90	2,190
3.40	170	4.60	455	5.80	1,120	7.00	2,300
3.50	190	4.70	490	5.90	1,200	7.10	2,410
3.60	210	4.80	525	6.00	1,290		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is not well defined. Above gage height 6.80 feet the rating curve is a tangent, the difference being 110 per tenth.

Estimated monthly discharge of Ramapo River near Mahwah, N. J., for 1903 and 1904.

[Drainage area, 118 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
February 10–28	660	230	341	2.89	2.04
March	1,880	250	571	4.84	5.58
April	2,190	210	534	4.53	5.05
May	190	40	96	.814	.938
June	1,980	25	400	3.39	3.78
July	1,045	40	183	1.55	1.79
August	525	40	162	1.37	1.58
September	835	73	198	1.68	1.87
October	5,380	73	801	6.79	7.83
November	715	210	281	2.38	2.66
December [a]	.....	.....	357	3.03	3.49

[a] Frozen December 17 to 22 and 30 to 31; monthly mean estimated.

Estimated monthly discharge of Ramapo River near Mahwah, N. J., etc.—Continued.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1904.					
January [a]	.....	.....	260	2.20	2.54
February [a]	.....	.....	300	2.54	2.74
March	2,410	295	562	4.76	5.49
April	1,200	230	430	3.64	4.06
May	455	150	247	2.09	2.41
June	425	56	191	1.62	1.81
July	775	40	123	1.04	1.20
August	210	40	66	.560	.64
September	1,120	11	152	1.29	1.44
October	2,190	40	243	2.06	2.37
November	295	170	215	1.82	2.03
December [b]	.....	.....	182	1.54	1.78
Total	2,410	11	248	2.10	28.52

[a] Ice conditions during January and February, mean flow for month estimated.
[b] Monthly mean estimated.

WANAQUE RIVER AT WANAQUE, N. J.

This station was established December 16, 1903, by F. H. Tilling hast. It is located at the highway bridge just above the Erie Rai way bridge and below the factory of the Wanaque River Pap Company. The standard chain gage is situated on the upstream sic of the bridge. The gage pulley is located at a point 73 feet from tl right abutment. The length of the chain from the end of the weigl to the marker is 17.52 feet. Bench mark No. 1 is a circular chisel dra on the upstream side of the right abutment. Its elevation is 13.8 feet above gage datum. Bench mark No. 2 is a square chisel draft c the upstream edge of the last stone upstream of the right abutme wing wall. Its elevation is 14.21 feet above gage datum. Benc mark No. 3 is the upper edge of lower chord on the upstream side c the bridge, 1.1 feet from the down spout. Its elevation is 13.58 fe above gage datum. Discharge measurements are made from tl upstream side of the single-span highway bridge, which has a lengt between abutments of 98.5 feet. The initial point for soundings the face of the right abutment on the upstream side. The channel straight for 300 feet above and 200 feet below the station. The cu rent is sluggish at low water. The right bank is high, rocky, ar wooded, while the left bank is low and without trees. All wat

passes under the bridge at all stages. The bed of the stream is composed of gravel, with occasional bowlders. At ordinary stages the depth of the water at the gaging section is from 2 to 5 feet. The gage is read twice daily by J. Herbert Hunter.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Wanaque River at Wanaque, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1904.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 5	F. H. Tillinghast	86	362	1.01	2.81	367
May 17	F. H. Brundage	82	292	.52	2.04	153
June 3	J. C. Hoyt	84	338	.80	2.60	269
August 5	do		202	.054	.97	11
November 10	Hoyt and Murphy	84	232	.24	1.35	56
December 10	F. H. Tillinghast	85	308	.61	2.25	187

Mean daily gage height, in feet, of Wanaque River at Wanaque, N. J., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	2.20	2.40	2.30								1.56
2	2.09	2.20	2.38	2.30								1.52
3	2.90	2.20	2.30	2.45								1.52
4	2.90	[a] 2.15	2.28	2.80								1.40
5	2.95	2.12	2.20	2.80								1.27
6	2.90	2.10	2.20	2.70								1.42
7	2.10	2.10	4.30	2.50								1.42
8	2.10	2.10	6.30	2.40								1.40
9	2.10	2.10	5.95	2.40								1.32
10	2.10	2.10	5.25	2.40								[b] 1.29
11	2.10	2.10	4.60	2.40								1.34
12	2.10	2.10	3.85	2.40								1.39
13	2.10	2.10	3.15	2.30								1.32
14	2.10	2.10	2.70	2.22								1.30
15	2.09	2.10	2.40	2.18								1.45
16	2.10	2.20	2.40	2.00								1.57
17	2.10	2.20	2.40	2.00								1.58
18	(c)	2.20	2.40	2.00								
19		2.20	2.40	1.90								
20		2.20	2.40	1.90								
21		2.30	2.40	1.90								
22		3.15	2.50	1.90								
23		2.80	2.80	1.85								
24		2.72	2.85	1.85								
25	2.50	2.70	2.80									
26	2.50	2.60	2.70									
27	2.40	2.60	2.60								1.55	
28	2.40	2.50	2.40								1.62	
29	[d] 2.30	2.50	2.40								1.65	
30	2.28		2.30								1.60	
31	2.20		2.30									

[a] River open. [b] *River frozen.* [c] Gage broken. [d] Ice 6 inches thick.

ROCKAWAY RIVER NEAR BOONTON, N. J.

This station was established March 15, 1903, by the United States Weather Bureau, by which it is maintained. It is located at Remine's bridge, about 3 miles downstream from Boonton. The gage is a vertical 2 by 12 inch board spiked to the face of the right abutment at its downstream end. It reads from 0 to 9 feet, and is graduated with copper staples. The bench mark is a square chiseled on the top of the upstream end of the right abutment. Its elevation above the gage datum is 9.14 feet. The gage reader for the Weather Bureau is Mrs. L. A. Van Derhoff. Discharge measurements are made from the downstream side of the single-span highway bridge, to which the gage is attached. The initial point for soundings is the face of the right abutment. The channel is straight for 300 feet above and below the station and the current is sluggish. Both banks are low, but will overflow only at very high water. The right bank is without trees; the left bank is wooded. The bed of the stream is composed of gravel with a few bowlders. There is a timber dam about 1 mile above the station. This station was discontinued February 2, 1904.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurement of Rockaway River near Boonton, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 16	F. H. Brundage	90	142	1.68	1.25	238

Mean daily gage height, in feet, of Rockaway River near Boonton, N. J., for 1904.

Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.
1	2.00	2.50	9			17			25	4.00	
2	2.00	2.50	10			18			26	3.90	
3			11			19			27	3.60	
4			12			20			28	3.50	
5			13			21			29	2.90	
6			14			22			30	2.50	
7			15			23	3.70		31	2.50	
8			16			24	3.50				

NOTE.—River frozen during January and February.

RARITAN RIVER DRAINAGE BASIN.

Raritan River, which is the largest stream in New Jersey, excepting the Delaware, rises in the highlands at the foot of Lake Hopatcong. The total area of the drainage basin is 1,105 square miles. The highlands consist mostly of trap rock and contain a large proportion of the wooded areas of the basin. Only about 10 per cent of the total

rea is forested. The area outside the highlands consists of either rap rock or red sandstone. Of the 806 square miles of drainage area bove the gaging station at Bound Brook, about 150 square miles are n the cultivated part of the highlands and on the trap ridges; the emainder is mostly on the low, level, red sandstone plain.

The valley of the Raritan is populous and highly cultivated, and a rge amount of water power is utilized on its various branches. Raritan River throughout almost its entire length is in two parts, amely, the North and South branches. The North Branch is conidered a valuable source for a gravity water supply. The upper ortion is at an elevation ranging from 750 to 1,100 feet. Both the Iorth and South branches rise close to each other, separated only by a light divide. The other important branch is Millstone River, which liffers from the other branches, having its rise in sand hills and flowng northwesterly through a sandy soil. It has a large ground storage. This stream is better suited for power than for water supply, being very muddy at high stages. All three branches are united above Bound Brook, N. J.

The United States Geological Survey maintained gaging stations in this basin during 1904 as follows: Raritan River (South Branch) at Stanton, N. J.; Raritan River at Finderne, N. J.; Raritan River at Bound Brook, N. J.; Raritan River (North Branch) at Pluckemin, N. J.; Millstone River at Millstone, N. J.

RARITAN RIVER (SOUTH BRANCH) AT STANTON, N. J.

This station was established July 2, 1903, by E. P. Roundey. It is located at the highway bridge about 500 feet from the Lehigh Valley Railroad station at Stanton, N. J. The standard chain gage is located on the lower chord of the bridge on the downstream side. The length of the chain from the end of the weight to the marker is 14.63 feet. Bench mark No. 1 is a square chiseled on the coping of the left abutment 1½ feet from the downstream end. It is 13.37 feet above gage datum. Bench mark No. 2 is the top of the upstream corner of the right abutment. It is 13.665 feet above gage datum. Bench mark No. 3 is a nail projecting one-quarter inch from downstream side of a arge sycamore tree 210 below bridge and 6 feet above the ground. Elevation 11.024 feet above gage datum. Discharge measurements re made from the downstream side of the single-span highway bridge. The initial point for soundings is the face of the right abutment. The hannel is straight for 800 feet above and 400 feet below the station. The current is swift. Both banks are low and liable to overflow. The ed of the stream is composed of gravel, and there is but one channel nder the bridge. The gage is read twice each day by William Wilson, the station agent.

The observations at this station during 1904 have been made und the direction of N. C. Grover, district hydrographer.

Discharge measurements of Raritan River (South Branch) at Stanton, N. J., in 1904

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Dis-charg
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-fe*
June 7	J. C. Hoyt	99	178	1.14	2.92	[illegible]
August 24	do	95	154	.98	2.77	[illegible]
November 8	H. D. Comstock	92	148	1.04	2.70	[illegible]

Mean daily gage height, in feet, of Raritan River (South Branch) at Stanton, N. J., 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	D
1	4.24	3.90	4.98	4.68	2.88	2.72	2.25	2.62	2.24	2.58	2.81	[illegible]
2	4.18	3.91	4.58	4.45	2.85	2.71	2.23	2.44	2.24	2.66	2.84	[illegible]
3	4.09	3.91	5.85	3.58	2.81	2.72	2.19	2.28	2.24	2.58	2.80	[illegible]
4	4.12	3.80	5.40	3.36	2.78	2.69	2.20	2.89	2.26	2.54	2.79	[illegible]
5	4.16	3.74	4.65	3.28	2.71	2.72	2.21	2.61	2.21	2.56	2.80	[illegible]
6	4.12	3.84	4.14	3.21	2.71	2.78	2.19	2.75	2.21	2.55	2.84	[illegible]
7	4.18	4.50	7.70	3.20	2.71	2.86	2.62	2.62	2.29	2.51	2.84	[illegible]
8	3.98	4.32	5.72	3.18	2.70	2.72	3.08	2.65	2.29	2.55	2.82	[illegible]
9	4.10	3.98	3.70	3.45	2.70	2.86	2.98	2.68	2.30	2.54	2.80	[illegible]
10	4.05	3.84	3.42	3.44	2.70	2.72	3.18	2.91	2.29	2.49	2.74	[illegible]
11	4.08	3.78	3.29	3.24	2.64	2.49	2.98	2.79	2.26	2.51	2.80	[illegible]
12	4.10	3.75	3.14	3.15	2.64	2.49	2.66	2.86	2.30	3.27	2.85	[illegible]
13	4.10	3.71	3.14	3.11	2.61	2.58	2.95	2.79	2.30	3.04	2.84	[illegible]
14	4.22	3.68	3.04	3.11	2.61	2.54	2.68	2.69	3.07	2.85	2.82	[illegible]
15	4.25	3.58	2.92	3.08	2.88	2.38	2.48	2.69	7.78	2.79	2.80	[illegible]
16	4.10	3.54	3.09	2.92	2.80	2.26	2.44	2.62	5.70	2.77	2.84	[illegible]
17	4.08	3.50	3.16	2.91	2.65	2.13	2.31	2.51	3.84	2.69	2.84	[illegible]
18	3.98	3.20	3.92	2.90	2.68	2.22	2.45	2.36	3.35	2.59	2.85	[illegible]
19	3.80	3.28	4.48	2.82	2.84	2.25	2.36	2.31	2.96	2.47	2.88	[illegible]
20	3.80	3.22	4.45	2.89	2.70	2.24	2.26	3.45	2.91	2.51	2.97	[illegible]
21	3.88	3.12	3.56	2.84	2.64	2.29	2.19	3.19	2.81	6.34	3.10	[illegible]
22	4.10	9.55	3.38	2.80	2.58	2.29	2.15	2.86	2.79	5.44	3.09	[illegible]
23	8.92	7.35	3.62	2.79	2.55	2.25	2.25	2.99	2.72	4.02	3.05	[illegible]
24	4.95	6.15	3.38	2.78	2.54	2.33	2.24	2.76	2.68	3.82	3.02	[illegible]
25	4.46	5.96	3.28	2.77	2.62	2.25	2.56	2.71	2.64	3.71	3.02	[illegible]
26	4.10	5.45	3.32	2.78	2.59	2.20	2.56	2.72	2.62	3.69	3.04	[illegible]
27	4.02	4.98	3.25	3.20	2.59	2.31	2.51	2.60	2.64	3.46	2.99	[illegible]
28	3.98	5.85	3.16	3.34	2.62	2.21	2.51	2.52	2.69	3.31	2.92	[illegible]
29	3.89	5.26	3.07	3.05	2.54	3.42	2.32	2.30	2.71	3.12	2.93	[illegible]
30	3.95	.....	3.01	2.91	2.47	2.60	2.41	2.31	2.69	2.94	2.91	[illegible]
31	3.94	.....	3.42	.....	3.12	.....	2.29	2.29	.....	2.81	.....	[illegible]

NOTE.—River frozen from January 1 to March 3, when ice went out. Thickness of ice varied fr 2 to 12 inches. March 7, highest record 11.04. River frozen December 8 to 29. Thickness of one-fourth to 6½ inches. During the frozen periods the gage heights were taken to the surfac the ice.

Rating table for Raritan River (South Branch) at Stanton, N. J., from July 2, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.10	42	2.90	194	3.70	505	4.40	840
2.20	56	3.00	226	3.80	550	4.50	890
2.30	71	3.10	260	3.90	596	4.60	940
2.40	87	3.20	296	4.00	643	4.70	990
2.50	104	3.30	335	4.10	691	4.80	1,040
2.60	122	3.40	376	4.20	740	4.90	1,090
2.70	142	3.50	418	4.30	790	5.00	1,140
2.80	166	3.60	461				

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.7 feet and 4.4 feet. The table has been extended beyond these limits. Above gage height 4.4 feet the rating curve is a tangent, the difference being 50 per tenth. The curve is very uncertain above gage height 5 feet.

Estimated monthly discharge of Raritan River (South Branch) at Stanton, N. J., for 1904.

Month.	Discharge in second-feet.			Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.		Maximum.	Minimum.	Mean.
January [a]	.....	.....	.....	July	289	49	108
February [a]	.....	.....	.....	August	397	68	146
March	2,490	200	629	September	2,530	58	263
April	980	159	302	October	1,810	99	308
May	267	99	143	November	260	152	192
June	384	46	113	December [a]	.....	.....	.....

[a] River frozen from January 1 to March 3 and from December 8–29, inclusive.

RARITAN RIVER AT FINDERNE, N. J.

This station was established June 27, 1903, by E. P. Roundey. It is located at the highway bridge, one-fourth mile from the New Jersey Central Railway station at Finderne, N. J. The standard chain gage is located on the downstream side of the right-hand truss on the lower chord. The length of the chain from the end of the weight to the end of the ring is 19.56 feet. Bench mark No. 1 is a cross chiseled on the coping of the downstream wing wall of the right abutment. Its elevation is 20.11 feet above gage datum. Bench mark No. 2 is the top of the outside connection plate near the zero of the gage scale. Its elevation is 20.14 feet above gage datum. The elevation of the top of the gage pulley is 19.21 feet above gage datum. Discharge measurements are made from the upstream side of the 2-span highway bridge. The initial point for soundings is the face of the right abut-

ment. The channel is straight for 300 feet above and 800 feet below the station. The current is swift. The right bank is low, wooded, and liable to overflow. The left bank will overflow only at extreme high water. The bed of the stream is composed of gravel. The channel is broken by the center pier of the 2-span bridge. The gage is read twice each day by Harry Siegel.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Raritan River at Finderne, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 11	F. H. Tillinghast	196	322	3.35	4.80	1,080
May 12	F. H. Brundage	168	203	2.17	4.04	440
June 6	J. C. Hoyt	160	237	2.45	4.20	580
July 30	do	155	186	1.84	3.92	343
November 10	H. D. Comstock	163	210	1.98	4.10	416

Mean daily gage height, in feet, of Raritan River at Finderne, N. J., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 4.75	a 4.75	4.75	7.98	4.38	4.18	3.80	3.88	3.90	3.95	4.20	3.95
2	a 4.85	a 6.30	4.70	7.35	4.55	3.90	3.88	4.33	3.83	3.90	4.20	3.90
3	4.50	a 6.15	4.90	5.08	4.35	4.02	3.63	4.10	3.85	3.98	4.12	4.00
4	4.90	a 5.55	6.18	4.98	4.20	3.90	3.60	4.00	3.60	3.97	4.10	3.95
5	5.28	a 5.08	5.20	4.80	4.20	3.92	3.62	4.25	3.65	3.95	4.10	3.95
6	5.55	4.90	4.62	4.58	4.15	4.18	3.63	5.30	3.68	3.92	4.10	4.00
7	5.15	5.40	7.55	4.68	4.10	4.32	3.68	4.20	3.65	3.85	4.28	3.90
8	5.05	6.90	11.05	4.65	4.00	4.15	5.20	4.13	3.72	3.85	4.02	4.00
9	5.05	5.05	5.85	4.82	4.00	4.35	4.45	4.00	3.65	3.80	4.02	3.85
10	5.05	4.35	4.90	5.30	4.02	4.15	3.95	5.62	3.68	3.92	4.00	3.82
11	5.10	4.35	4.80	4.80	4.02	4.00	4.20	7.25	3.65	3.92	4.08	3.85
12	5.10	4.15	4.65	4.65	4.00	3.85	3.95	4.60	3.65	5.85	4.10	3.82
13	5.00	4.10	4.40	4.52	4.92	3.85	4.08	4.25	3.65	4.85	4.48	4.10
14	7.98	4.10	4.45	4.35	4.88	3.80	3.88	4.85	3.65	4.35	7.52	4.20
15	6.88	4.10	4.45	4.35	3.70	3.70	3.75	4.32	14.90	4.25	5.00	4.18
16	7.10	4.00	5.05	4.32	4.10	3.65	3.60	4.12	6.88	4.12	4.78	4.22
17	6.68	4.30	4.55	4.20	3.95	3.62	3.52	4.05	5.15	4.00	4.92	4.20
18	7.50	4.42	4.60	4.20	3.95	3.58	3.62	3.90	4.78	4.02	4.90	4.10
19	7.20	4.75	5.30	4.15	3.97	3.55	3.80	3.93	4.65	3.93	4.40	4.10
20	7.20	4.90	4.95	4.15	4.25	3.60	3.70	6.98	4.42	3.88	4.30	4.00
21	7.20	4.75	4.90	4.10	4.08	3.62	3.60	5.75	4.32	8.38	4.30	4.0[illegible]
22	5.65	a 12.72	5.00	4.30	3.92	3.65	3.70	4.63	4.20	8.30	4.30	4.0[illegible]
23	a 12.70	7.62	5.45	4.00	3.85	3.60	3.68	4.40	4.30	5.30	4.30	4.[illegible]
24	7.68	5.58	5.08	4.05	3.92	3.60	3.55	4.25	4.12	4.95	4.20	4.[illegible]
25	5.00	5.65	4.92	4.10	3.82	3.52	3.65	4.20	4.10	4.70	4.15	4.[illegible]
26	4.90	4.82	5.07	4.30	3.85	3.48	3.78	4.05	3.98	4.68	4.10	4.[illegible]
27	4.45	4.45	5.10	4.90	3.72	3.55	3.65	4.03	3.97	4.50	4.00	4.[illegible]
28	4.35	4.78	4.95	5.45	3.80	3.55	3.85	4.00	4.00	4.30	3.88	8.[illegible]
29	4.70	5.65	4.85	4.80	3.62	3.60	5.05	3.95	4.00	4.30	3.85	7.[illegible]
30	a 6.00	.....	4.75	4.62	3.60	3.98	3.98	3.88	3.98	4.18	4.50	6.[illegible]
31	a 5.00	.....	4.95	.....	4.22	.....	3.80	3.90	.....	4.18	.....	6.[illegible]

a Ice gorge causes water to rise.

NOTE.—Highest reading September 15, 15.30; October 21, 12.65.

ating table for Raritan River at Finderne, N. J., from June 27, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.50	125	5.00	1,255	6.40	2,825	8.60	5,650
3.60	171	5.10	1,355	6.50	2,945	8.80	5,930
3.70	219	5.20	1,460	6.60	3,065	9.00	6,210
3.80	272	5.30	1,565	6.70	3,190	9.20	6,500
3.90	330	5.40	1,675	6.80	3,315	9.40	6,800
4.00	393	5.50	1,785	6.90	3,440	9.60	7,100
4.10	461	5.60	1,895	7.00	3,565	9.80	7,410
4.20	534	5.70	2,005	7.20	3,815	10.00	7,730
4.30	612	5.80	2,120	7.40	4,065	10.50	8,580
4.40	695	5.90	2,235	7.60	4,325	11.00	9,430
4.50	783	6.00	2,350	7.80	4,585	11.50	10,280
4.60	875	6.10	2,465	8.00	4,845	12.00	11,130
4.70	969	6.20	2,585	8.20	5,110	12.50	11,980
4.80	1,064	6.30	2,705	8.40	5,380	13.00	12,830
4.90	1,159						

The above table is applicable only for open-channel conditions. It is based upon 2 discharge measurements made during 1903 and 1904. It is fairly well defined etween gage heights 3.90 feet and 10.50 feet. The table has been extended beyond hese limits. Above gage height 10 feet the rating curve is a tangent, the difference eing 170 per tenth.

Estimated monthly discharge of Raritan River at Finderne, N. J., for 1904.

Month.	Discharge in second-feet.			Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.		Maximum.	Minimum.	Mean.
arch	9,515	695	1,580	August	3,878	318	856
pril	4,819	393	1,081	September	16,060	171	1,043
ay	1,178	171	460	October	5,353	272	920
une	654	116	296	November	4,221	301	723
uly	1,460	134	343	December	5,178	284	886

RARITAN RIVER AT BOUND BROOK, N. J.

This station was established September 12, 1903, by E. P. Roundey It is located at the highway bridge just back of the Lehigh Valley Railway station at Bound Brook, N. J. The original gage consiste of a vertical 1¼ by 6 inch cypress board 12 feet long bolted to th upstream wing wall of the right abutment. It was carried away b the ice January 23, 1904. On February 2, 1904, a standard chain gag was bolted to the upstream side of the bridge 240 feet from the righ abutment. The length of the chain from the end of the weight to th marker is 23.48 feet. Bench mark No. 1 is a square chiseled on top o the upstream wing wall of the right abutment. Its elevation is 19.4 feet above gage datum. Bench mark No. 2 is the top of the rail 2 fee beyond the pulley end of the gage. Its elevation is 23.77 feet abov gage datum. Bench mark No. 3 is a point on the guard rail of th bridge 225 feet from the initial point for soundings. Its elevation i 20.75 feet above gage datum. Discharge measurements are mad from the upstream side of the 3-span highway bridge. The initia point for soundings is the face of the right abutment. The channel i straight for 500 feet above and below the station, and the current ha a moderate velocity. Both banks are high, subject to overflow onl at very high stages, and are without trees. The bed of the stream i composed of gravel. The gage is read twice each day by Joseph K Tantum.

The observations at this station during 1904 have been made unde the direction of N. C. Grover, district hydrographer.

Discharge measurements of Raritan River at Bound Brook, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 11	F. H. Tillinghast	403	1,234	1.43	2.12	1,76
May 11	F. H. Brundage	404	1,006	.66	1.44	66
June 6	J. C. Hoyt	381	1,084	.81	1.55	87
July 30	do	378	1,016	.48	1.48	49
November 10	H. D. Comstock	384	1,052	.67	1.52	70

m daily gage height, in feet, of Raritan River at Bound Brook, N. J., for 1904.

y.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.80	(a)	2.25	4.00	.....	1.70	1.70	1.40	1.35	1.45	1.60	1.55
.....	1.80	2.10	2.40	4.00	.....	1.70	1.70	1.75	1.40	1.40	1.55	1.45
.....	1.80	1.85	2.35	2.70	.....	1.60	1.60	1.70	1.40	1.40	1.50	1.40
.....	1.60	1.70	2.95	2.20	.....	1.50	1.50	1.55	1.40	1.40	1.50	1.40
.....	1.50	1.60	1.90	2.10	.....	1.40	1.60	2.85	1.30	1.35	1.50	1.35
.....	1.50	1.60	1.60	1.90	.....	1.55	1.60	3.40	1.30	1.30	1.50	1.35
.....	1.50	1.85	3.85	2.00	.....	1.55	1.95	2.20	1.30	1.30	1.50	1.40
.....	1.50	4.10	8.60	1.95	1.40	1.80	2.55	1.90	1.30	1.30	1.50	1.40
.....	1.50	3.45	3.60	2.10	1.40	2.00	1.90	1.70	1.30	1.30	1.50	1.40
.....	1.50	3.15	2.35	2.60	1.40	1.65	1.60	3.20	1.30	1.30	1.50	1.40
.....	1.50	2.85	1.95	2.15	1.40	1.50	1.55	4.60	1.30	1.30	1.65	1.40
.....	1.50	2.10	1.75	1.95	1.35	1.40	1.55	2.65	1.30	3.30	1.80	1.40
.....	1.50	1.80	1.65	1.85	1.30	1.40	1.50	2.40	1.30	3.30	1.75	1.35
.....	3.30	1.65	1.50	1.70	1.35	1.40	1.45	2.15	1.30	2.20	4.25	1.30
.....	2.95	1.75	1.65	1.60	1.40	1.40	1.40	2.00	c10.10	1.80	2.95	1.40
.....	2.40	1.65	1.80	1.60	1.45	1.35	1.40	1.75	5.45	1.70	2.40	1.40
.....	2.30	1.65	1.80	1.60	1.40	1.30	1.40	1.65	3.70	1.60	2.15	1.30
.....	2.30	1.65	1.80	1.60	1.40	1.30	1.35	1.55	2.35	1.55	1.95	1.35
.....	2.20	1.60	2.90	1.50	1.30	1.30	1.40	1.45	2.15	1.55	1.90	1.30
.....	2.10	1.60	2.65	1.50	1.45	1.25	1.35	4.50	1.90	1.45	1.85	1.30
.....	2.00	1.50	2.35	1.45	1.50	1.20	1.25	4.70	1.75	4.35	1.70	1.30
.....	2.00	b9.46	2.60	1.40	1.40	1.20	1.20	3.40	1.70	6.35	1.70	1.30
.....	d7.90	5.25	2.80	1.40	1.30	1.20	1.25	2.55	1.60	3.25	1.65	1.30
.....	(e)	4.25	2.40	1.40	1.25	1.15	1.30	2.05	1.60	2.60	1.60	1.40
.....	(e)	2.65	2.10	1.40	1.20	1.10	1.25	1.80	1.60	2.30	1.60	1.60
.....	(e)	2.30	2.45	1.40	1.20	1.15	1.25	1.65	1.60	2.05	1.60	2.10
.....	(e)	2.05	2.50	2.45	1.20	1.15	1.20	1.60	1.60	1.95	1.55	1.80
.....	(e)	2.40	1.90	.....	1.20	1.25	1.40	1.50	1.60	1.75	1.50	3.85
.....	(e)	3.15	1.75	.....	1.20	1.50	2.15	1.45	1.50	1.70	1.45	3.90
.....	(e)	.....	1.70	.....	1.20	1.75	1.40	1.40	1.45	1.70	1.60	3.15
.....	(e)	.....	1.70	.....	1.65	.....	1.35	1.40	.....	1.60	.....	2.90

: frozen except under gage. d Ice jam in morning; river clear in evening.
one out; river clear; highest reading 11.2 feet. e Gage carried out by ice.
est gage reading 11.7 during flood.

–River frozen from January 1 to February 22. Thickness of ice varied from 2 to 12 inches.
ight to surface of ice.

RARITAN RIVER (NORTH BRANCH) NEAR PLUCKEMIN, N. J.

s station was established September 9, 1903, by E. P. Roundey. ocated at the second bridge below Far Hills, N. J., on the road merville, N. J., about 2 miles from Far Hills. The gage is a al 1¼ by 6 inch cypress board spiked to the upstream wing wall e right abutment, reading from 0 to 10 feet. The gage is read each day by Thomas Moore. Discharge measurements are made the single-span wooden highway bridge on the downstream side. nitial point for soundings is the face of the right abutment at its stream end. The channel is straight for 400 feet above and 300 elow the bridge. A small rift occurs in the channel about 200 bove the bridge. The current is sluggish. Both banks are low able to overflow. The bed of the stream is composed of gravel. is but one channel under the bridge. The bench mark is a

square chiseled on the top of the upstream wing wall of the rig abutment. Its elevation is 10.38 feet above the zero of the gage.

The observations at this station during 1904 have been made und the direction of N. C. Grover, district hydrographer.

Discharge measurements of Raritan River (North Branch) near Pluckemin, N. J., 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Dis-charg
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-fa*
May 12	F. H. Brundage	55	160	0.35	1.51	
November 9	H. D. Comstock	55	172	.37	1.70	

Mean daily gage height, in feet, of Raritan River (North Branch) near Pluckemin, N. for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	De
1	2.50	3.00	2.30	2.85	2.00	2.30	1.65	1.95	1.40	1.80	1.80	1
2	2.50	3.20	2.80	2.50	2.10	2.30	1.40	1.70	1.40	1.70	1.80	1
3	2.50	3.20	2.60	2.30	1.80	2.35	1.40	1.52	1.40	1.60	1.80	1
4	2.50	3.20	2.30	2.05	1.80	2.10	1.40	2.65	1.40	1.60	1.80	1
5	2.50	3.20	1.90	2.00	1.70	2.15	1.30	2.05	1.40	1.60	1.80	
6	2.50	3.20	1.90	2.00	1.70	1.65	1.30	1.70	1.40	1.60	1.80	
7	2.50	3.45	5.25	2.00	1.55	1.90	2.00	1.50	1.40	1.50	1.75	
8	2.50	3.70	3.00	2.00	1.50	1.50	2.80	1.50	1.40	1.50	1.70	
9	2.50	3.30	2.45	2.10	1.50	2.05	1.65	1.50	1.40	1.85	1.70	
10	2.50	3.20	2.25	2.10	1.55	1.70	2.00	2.80	1.40	1.65	1.70	
11	2.50	3.20	2.20	2.10	1.60	1.58	1.70	2.65	1.40	2.80	1.80	
12	2.50	3.20	2.08	2.20	1.55	1.48	1.75	2.15	1.40	1.85	1.70	
13	2.65	3.20	1.95	2.10	1.50	1.40	1.70	1.90	1.40	1.70	2.85	
14	3.00	3.20	1.80	2.05	1.50	1.40	1.40	1.83	3.55	1.70	2.50	
15	2.70	2.80	1.80	1.90	1.60	1.40	1.50	1.68	(a)	1.70	2.18	
16	2.70	2.80	1.80	1.90	1.70	1.40	1.30	1.60	.....	1.70	2.10	
17	2.70	2.80	1.80	1.80	1.60	1.40	1.30	1.58	.....	1.60	2.00	
18	2.70	2.80	2.00	1.80	1.60	1.35	1.65	1.50	3.00	1.60	2.00	
19	2.70	2.80	2.00	1.70	1.80	1.30	1.50	4.40	2.90	1.60	2.00	
20	2.70	2.80	2.10	1.70	1.90	1.30	1.35	3.00	2.60	1.52	2.95	
21	2.70	2.80	2.10	1.70	1.60	1.40	1.30	1.90	2.50	4.55	2.90	
22	2.75	6.15	2.10	1.70	1.52	1.40	1.30	1.78	2.40	2.80	2.88	
23	b 6.26	3.55	2.10	1.70	1.50	1.40	1.30	1.70	2.30	2.55	2.80	
24	4.70	4.25	2.10	1.70	1.50	1.40	1.45	1.63	2.30	2.25	2.78	
25	2.90	3.95	2.10	1.70	1.50	1.30	1.65	1.60	2.30	2.05	2.70	
26	2.85	3.52	2.15	1.70	1.50	1.30	1.60	1.60	2.30	1.95	2.70	
27	3.00	3.50	2.15	2.25	1.40	1.28	1.30	1.60	2.20	1.90	2.70	
28	3.00	3.25	2.05	2.15	1.30	1.20	1.65	1.55	2.20	1.90	2.55	
29	3.00	2.55	1.80	2.00	1.30	1.65	2.20	1.48	1.90	1.90	2.35	
30	3.00	.....	1.82	2.00	1.90	1.65	1.90	1.43	1.80	1.90	2.15	
31	3.00	.....	2.45	.....	2.38	.....	2.00	1.40	.....	1.88	.....	

a Gage washed away on 14th; put up again on 18th.
b Ice went out; greatest height, 6.8. River frozen again the 24th.

NOTE.—River frozen from January 1 to March 1, when ice went out. Thickness of ice varied f 6 to 12 inches. River frozen December 8-31. Gage heights to surface of ice.

MILLSTONE RIVER AT MILLSTONE, N. J.

This station was established June 26, 1903, by E. P. Roundey. It ocated at a highway bridge near the blacksmith shop in the village Millstone, N. J. The gage is a vertical 1¼ by 6-inch cypress ırd, spiked to the left abutment of the bridge on the downstream e. It reads from 0 to 10 feet, and is graduated with galvanized- ın staples. The bench mark is a cross chiseled on the coping near the d of the downstream wing wall of the left abutment. Its elevation 11.11 feet above the zero of the gage. The gage is read twice each y by E. H. Wyckoff, the blacksmith. Discharge measurements are ıde from the upstream side of the single-span highway bridge, to ıich the gage is attached. The bridge has a span of 93 feet and located about 1 mile above a dam. The gage heights may be fluenced by this dam and also by backwater from Raritan River. ıe initial point for soundings is the face of the left abutment. The annel is straight for 500 feet above and 100 feet below the station. ıe current is sluggish at low water. Both banks are low, wooded, and ıble to overflow. At extreme high water the right bank overflows r a considerable distance. The bed of the stream is composed of avel. This station was discontinued December 31, 1904.

The observations at this station during 1904 have been made under e direction of N. C. Grover, district hydrographer.

Discharge measurements of Millstone River at Millstone, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
ɔril 11	F. H. Tillinghast	93	372	1.60	1.19	596
ne 26	J. C. Hoyt	93	293	.86	.27	251
ly 30	do	93	268	.44	.05	118
ɔvember 10	H. D. Comstock	93	352	.70	.84	247

Mean daily gage height, in feet, of Millstone River at Millstone, N. J., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.55	0.58	1.85	3.12	1.02	0.68	−0.04	0.15	0.25	(a)	0.80	0.85
2	.35	.50	2.22	3.65	.68	1.38	− .01	.52	.22	(a)	.87	.78
3	.30	.50	1.72	2.25	.60	.75	− .04	.50	.25	(a)	.85	.75
4	.30	.50	2.02	1.38	.50	.50	− .08	.52	.25	(a)	.87	.70
5	.50	.50	1.08	1.08	.35	.40	− .01	1.15	.15	(a)	.85	.65
6	.50	.50	.42	.88	.28	.30	− .02	.85	.18	0.58	.87	.60
7	.50	1.80	2.45	.92	.25	.72	.08	1.88	.18	.60	.75	.65
8	.50	3.72	6.20	.88	.20	1.08	.48	1.60	.15	.55	.78	.65
9	.50	1.85	4.02	1.08	.20	1.32	.45	.75	.06	.60	.87	.65
10	.50	1.15	1.88	1.60	.20	.85	.38	.65	.12	.55	.87	.65
11	.50	.75	1.08	1.20	.18	.42	.25	2.78	.20	.48	1.25	.65
12	.50	.35	.75	1.02	.20	.22	.18	2.78	.04	3.25	1.30	.65
13	.52	.28	.62	.82	.10	.10	.40	2.58	.01	4.65	1.52	.65
14	2.10	.25	.52	.62	.12	.05	.40	2.60	.15	1.98	4.27	.65
15	1.70	.18	.40	.52	.30	.02	.25	1.22	7.32	1.40	3.32	.65
16	1.25	.20	.55	.52	.18	.05	.20	.82	7.42	1.20	2.32	.65
17	1.05	.20	.80	.38	.02	.05	.10	.62	5.02	.98	1.80	.65
18	.60	.20	.85	.32	−.10	.02	.12	.40	2.20	.92	1.40	.65
19	.50	.20	2.12	.35	.12	−.02	.08	.30	1.30	.85	1.22	.65
20	.50	.20	1.62	.30	.20	−.16	.10	6.20	.95	.85	1.15	.65
21	.50	.20	1.18	.28	.22	.12	.10	6.75	.72	4.10	1.10	.65
22	.50	7.16	1.40	.20	.30	.02	− .03	5.15	.55	6.40	.98	.65
23	b6.88	6.90	1.65	.20	.10	.05	− .02	2.62	.48	3.55	.92	.65
24	6.20	c5.02	1.38	.10	.05	.00	− .03	1.90	.45	2.30	.92	.72
25	4.02	2.60	1.12	.15	.05	.00	.02	.88	.42	1.62	.90	.95
26	1.78	2.05	1.38	.18	.10	.03	− .07	.70	.25	1.32	.85	.90
27	3.02	.68	1.38	1.80	.02	.10	.02	.60	.32	1.25	.78	1.25
28	2.10	1.52	.92	2.68	f−.05	.01	.35	.52	.30	1.07	.68	4.00
29	1.45	2.00	.68	2.08	−.04	−.02	.20	.42	(a)	1.00	.68	2.80
30	.98	.....	.65	1.52	.01	−.08	.10	.38	(a)	.92	.88	2.35
31	.70	.....	1.05	.....	.50	.....	.10	.22	.....	.87	.....	2.02

a Below gage; drawn off to repair dam. b Caused by ice jam. c Ice gone out of river.

NOTE.—River frozen January 1 to February 23; also December 11 to 31. Ice 3 to 6 inches thick. Gage heights to surface of ice.

DELAWARE RIVER DRAINAGE BASIN.

Delaware River rises on the slope of Mine Mountain, near the southwestern line of Schoharie County, New York, flows southwesterly across central Delaware County to Deposit, where it is joined by Oquaga Creek, a large tributary draining eastern Broome County. The upper drainage area is relatively long and narrow, with numerous short lateral tributaries. It is rugged and to a considerable extent wooded. There are low water-power dams near Hamden and Delhi. At Deposit the stream turns abruptly to the southeast, forming the boundary line between New York and Pennsylvania, until Port Jervis is reached. Here it encounters the foot of the Shawangunk Range and its direction of flow is again turned to the southwest. Below Port Jervis the Delaware forms the division between Pennsylvania and New Jersey, and ultimately empties into Delaware Bay below Philadelphia.

above Hancock the main stream is known as the West Branch of Delaware River, to distinguish it from the smaller East or Pepacton Branch.

The West Branch of the Delaware is sometimes called the Mohawk. It should not be confused with Mohawk River, a tributary of Hudson River. The East Branch of the Delaware flows parallel to the West Branch across southern Delaware County, but its drainage area is broader and its tributaries longer and more branching than those of the West Branch. Many of the tributaries head in small lakes and ponds.

From Hancock to Port Jervis, a distance by river of 76 miles, the Delaware flows in a broad, shallow channel with numerous slight rifts and a relatively rapid current. Several large tributaries enter in this section of the stream, notably Mongaup and Callicoon creeks and Neversink River from the New York side, and the Lackawaxen River from Pennsylvania.

The drainage area of Delaware River above Port Jervis lies about four-fifths in New York and one-fifth in Pennsylvania.

Neversink River rises in southwestern Ulster County, two branches uniting to form the main stream near Sullivan County line. The stream then flows southerly, crossing eastern Sullivan County, and enters Delaware River at Port Jervis. Its fall is rapid and often precipitous, and its drainage basin contains numerous small lakes.

Measurements of flow of Delaware River were made during the latter half of June, 1891, by Prof. Dwight Porter and students at Delaware Watergap, Pa. The results show a flow of from 2,000 to 2,200 second-feet. This was said to be the lowest June stage for five years. Measurements were made during the drought of 1895 by Prof. A. M. Haupt at Point Pleasant, Pa., near the intake of the Delaware and Raritan Canal feeder. The discharge above the bridge was 1,657 second-feet and below the bridge 1,328 second-feet. Delaware River was measured by E. G. Paul, June 4, 1899, at Martins Creek, Pa., 7 miles above the mouth of Lehigh River, and a discharge of 2,724 second-feet was found.

Stations were maintained in this basin during 1904 by the United States Geological Survey as follows: Delaware River (West Branch) at Hancock, N. Y.; Delaware River (East Branch) at Hancock, N. Y.; Delaware River at Lambertville, N. J.; Lehigh River at South Bethlehem, Pa.; Musconetcong River near Bloomsbury, N. J.

Aside from these stations, measurements have been made for several years by John E. Codman, hydrographer of the water department of the city of Philadelphia. The stations maintained by Mr. Codman are located on the following streams, all in the vicinity of Philadelphia: Perkiomen, Tohickon, and Neshaminy creeks, and Schuylkill River.

DELAWARE RIVER (WEST BRANCH) AT HANCOCK, N. Y.

This station was established October 15, 1902, by P. M. Churchill, assisted by C. C. Covert. It is located about one-half mile southwest of the Erie Railroad station at Hancock, N. Y., and about 1 mile above the junction of the East and West branches of the Delaware. The original wire gage was attached to the upstream side of the bridge. It was replaced July 20, 1903, by a standard chain gage, which was installed by F. H. Tillinghast. The location and the gage datum were not changed. The length of the chain from the end of the weight to the marker is 30.44 feet. The gage is read twice each day by David Pulver, the collector of tolls at the bridge. Discharge measurements are made from the downstream side of the bridge at which the gage is located. The bridge has a single span of 235 feet. The initial point for soundings is the top of the face of the left abutment on the downstream side. The bridge floor is marked at intervals of 5 feet with black paint. The channel is straight for 400 feet above and for 800 feet below the bridge. The current is swift. Both banks are high and rocky and are not subject to overflow. The bed of the stream is composed of earth and cobblestones. The bench mark is a circular chisel draft on the upstream corner of the left abutment. Its elevation is 24.25 feet above gage datum. The elevation of the top of the pulley is 30.54 feet above gage datum.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Delaware River (West Branch) at Hancock, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Feet per sec.*	*Feet.*	*Second-feet.*
July 15	C. C. Covert	326	0.55	3.05	180
September 11	Covert and Swancott	408	.92	3.39	375

ily gage height, in feet, of Delaware River (West Branch) at Hancock, N. Y., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	5.82	7.47	9.71	5.79	4.98	3.49	3.26	3.65	3.45	4.35	3.85	3.90
.....	5.87	8.52	9.91	6.59	4.76	3.32	3.11	4.15	3.50	4.10	3.75	3.55
.....	5.37	7.97	10.06	5.64	4.56	3.39	2.94	4.90	3.55	3.90	3.75	3.35
.....	5.17	7.67	11.81	5.21	4.56	3.42	3.11	4.50	4.15	3.80	3.65	3.35
.....	4.57	7.42	12.41	5.13	4.27	3.81	3.11	4.10	4.20	3.75	3.55	3.30
.....	5.42	7.07	11.44	5.13	4.27	3.71	3.21	5.50	3.90	3.55	3.55	3.35
.....	5.77	7.82	11.39	5.46	4.02	3.46	3.01	4.20	3.70	3.45	3.60	3.45
.....	5.77	14.43	11.66	5.76	3.97	3.66	3.06	3.90	3.50	3.35	3.50	3.25
.....	5.72	13.26	11.81	5.83	3.92	4.41	3.08	3.75	3.40	3.45	3.40	3.80
.....	5.22	11.96	10.04	6.23	3.67	4.11	3.11	3.90	3.35	3.50	3.45	4.25
.....	5.42	11.86	8.69	5.73	3.57	3.96	3.06	4.85	3.40	3.50	3.40	4.75
.....	5.32	11.61	8.27	5.33	3.42	3.74	3.14	4.12	3.35	3.75	3.45	4.70
.....	5.12	11.81	6.91	5.03	3.57	3.48	3.06	3.80	3.10	3.90	3.40	4.70
.....	5.07	10.96	6.34	4.78	3.37	3.46	3.30	3.70	3.20	4.65	3.60	4.60
.....	4.42	11.01	6.14	4.53	4.27	3.46	3.10	3.80	4.40	4.40	3.40	4.50
.....	4.87	10.51	5.71	4.40	4.12	3.61	4.50	3.85	4.10	4.25	3.55	4.60
.....	5.02	10.06	5.81	4.43	4.12	3.68	3.80	3.55	3.55	4.05	3.35	4.25
.....	4.97	10.06	5.89	4.28	4.17	3.31	3.65	3.60	3.55	3.90	3.30	4.65
.....	4.67	10.01	5.87	4.03	3.97	3.26	3.60	3.60	3.55	3.90	3.35	4.45
.....	4.52	10.06	5.84	3.98	4.57	3.14	3.40	4.10	3.35	3.80	3.45	4.55
.....	4.72	10.06	6.09	4.03	4.32	3.21	3.30	4.75	3.15	5.30	3.90	4.40
.....	4.87	10.31	5.69	4.08	4.19	3.01	3.20	4.35	3.10	7.50	4.50	4.25
.....	6.32	11.11	7.81	3.98	3.92	3.06	3.10	5.40	3.10	5.95	4.40	4.45
.....	7.32	11.76	9.42	3.93	4.07	3.11	3.05	4.70	3.20	5.35	4.45	4.65
.....	5.62	10.56	8.84	3.98	3.77	3.16	3.00	4.85	5.00	5.00	4.25	4.85
.....	5.12	10.46	13.05	4.03	3.87	3.16	3.35	4.25	4.40	4.85	4.10	4.45
.....	6.27	10.01	7.54	4.16	3.62	2.94	4.15	4.05	4.50	4.55	3.95	4.95
.....	8.62	9.91	6.04	5.06	3.52	2.71	3.60	3.88	4.45	4.15	3.60	7.30
.....	8.32	10.06	5.39	5.20	3.37	3.06	4.20	3.72	3.90	4.15	3.55	5.75
.....	8.32	.....	5.24	5.10	3.37	2.84	3.90	3.80	4.65	3.95	4.05	5.05
.....	7.92	.....	5.04	.....	3.47	.....	3.80	3.50	.....	3.95	.....	4.60

Ice conditions January 1 to March 7; also December 9 to 27. Gage heights to surface of ice.

DELAWARE RIVER (EAST BRANCH) AT HANCOCK, N. Y.

This station was established October 14, 1902, by P. M. Churchill and C. C. Covert. It is located at the highway bridge one-half mile southeast of the Erie Railroad station at Hancock, N. Y., and 1 mile above the junction with the West Branch of Delaware River. The Erie Railroad bridge is just below the station. The standard chain gage with inclosed scale is attached to the lower chord of the second span from the left end of the bridge on the upstream side. It was installed to replace the old wire gage July 21, 1903, by F. H. Tillinghast. The gage datum was not changed. The length of the chain from the end of the weight to the marker is 32.43 feet. The gage is read twice each day by D. B. Van Etten. Discharge measurements are made from the downstream side of the 5-span iron highway bridge to which the gage is attached. The bridge has a total span of 425.5 feet between abutments. The initial point for soundings is the face of the right abutment at the top. The channel is straight for 600 feet above and for 300 feet below the station. The current is swift. Both banks are of medium height, and are not subject to overflow. The bed of the stream is composed of rocks and gravel and is not subject to change. There are three channels at low water and five channels at high water. The bench mark is a circular chisel draft on the top of the left abutment on the downstream side. It is marked "B. M." Its elevation is 27.93 feet above gage datum. The elevation of the top of the gage pulley is 32.40 feet above gage datum. During low water the elevation of the water surface at the station is lower than the water surface at the station on the West Branch of the Delaware, but there is no danger of the gage heights being affected by backwater from the West Branch, as there is considerable fall between the gaging station and the junction of the branches.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Delaware River (East Branch) at Hancock, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. ft.	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 14	C. C. Covert	586	0.98	3.26	578
September 11	Covert and Swancott	528	.77	3.04	408

ily gage height, in feet, of Delaware River (East Branch) at Hancock, N. Y., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	4.67	5.32	4.71	5.64	5.23	3.47	3.28	3.75	3.28	3.85	3.80	4.45
.....	4.97	4.77	4.81	6.93	4.96	3.39	3.26	3.75	3.28	3.62	3.70	4.32
.....	4.32	4.62	4.96	6.24	4.73	3.37	3.08	3.98	3.22	3.55	3.62	4.12
.....	4.17	4.52	4.86	5.64	4.56	3.37	2.96	3.78	3.35	3.48	3.60	4.22
.....	4.17	4.47	5.51	5.33	4.42	3.38	2.95	3.58	3.32	3.40	3.52	3.90
.....	4.17	4.42	5.79	5.43	4.25	3.54	2.95	3.48	3.18	3.32	3.60	4.05
.....	4.35	a6.81	7.54	6.03	4.15	3.58	2.97	3.38	3.12	3.30	3.58	4.15
.....	4.62	8.26	19.49	6.18	4.05	3.94	3.05	3.25	3.08	3.22	3.48	4.05
.....	4.49	8.21	13.99	7.13	3.95	4.18	2.97	3.20	3.10	3.20	3.40	3.90
.....	4.49	7.21	12.54	7.38	3.85	4.18	2.95	3.45	3.15	3.20	3.40	3.75
.....	4.77	6.91	12.74	6.83	3.77	3.94	2.90	4.35	3.08	3.20	3.40	4.05
.....	4.42	6.01	12.79	6.68	3.72	3.76	2.97	4.02	2.98	3.32	3.40	4.35
.....	4.22	5.61	12.79	6.28	3.65	3.64	3.30	3.70	2.90	4.05	3.35	4.40
.....	4.22	5.36	12.64	5.53	3.55	3.48	3.22	3.55	2.92	3.95	3.48	4.35
.....	4.42	5.31	12.69	4.78	3.69	3.46	3.08	3.55	3.28	3.78	3.42	4.45
.....	4.57	5.01	12.64	4.80	4.07	3.54	3.80	3.42	3.85	3.68	3.50	4.55
.....	4.87	4.71	12.44	4.58	3.95	3.41	3.58	3.32	3.42	3.60	3.45	4.65
.....	4.77	4.61	12.24	4.48	3.85	3.31	3.45	3.60	3.22	3.52	3.40	4.70
.....	4.67	4.51	12.14	4.38	3.85	3.26	3.65	3.52	3.12	3.50	3.40	4.70
.....	4.92	4.61	12.34	4.28	3.99	3.18	3.40	3.80	3.10	3.45	3.40	4.70
.....	5.22	4.56	12.24	4.16	3.92	3.16	3.22	4.70	3.05	9.02	3.60	4.70
.....	5.57	4.66	13.34	4.20	3.79	3.14	3.12	4.15	2.98	9.10	4.25	4.65
.....	5.52	5.11	14.49	4.23	3.67	3.08	3.08	4.52	2.92	6.38	4.18	4.65
.....	b9.32	5.01	15.74	4.10	3.72	3.06	3.05	4.18	3.00	5.50	4.15	4.55
.....	10.57	4.76	15.39	4.23	3.65	3.01	3.00	3.95	3.50	5.00	4.10	5.15
.....	9.32	4.61	17.04	4.23	3.57	2.98	3.18	3.88	3.60	4.75	4.02	4.85
.....	10.17	4.41	9.24	4.53	3.59	2.91	3.42	3.75	3.58	4.48	3.88	5.05
.....	10.12	4.61	6.49	5.13	3.55	2.88	3.35	3.58	3.48	4.28	3.75	7.10
.....	9.07	4.61	5.59	5.68	3.45	2.94	5.96	3.48	3.40	4.12	4.80	5.80
.....	8.07	.....	5.39	5.46	3.39	3.06	4.52	3.40	3.78	4.00	5.10	5.05
.....	5.42	.....	5.19	.....	3.45	.....	4.00	3.32	.....	3.88	.....	4.80

uary 24–30, back water from ice jam. *b* February 7–13, back water from ice jam.
River frozen from January 10 to March 21; also December 11–28. Gage heights to surface of hole cut in ice.

DELAWARE RIVER AT LAMBERTVILLE, N. J.

station was established at the covered toll bridge on July 23, by E. G. Paul. The datum of the chain gage was 2 feet below the United States Weather Bureau gage painted on the first pier, and was referred to a copper bolt set in the sill of the he south door at the east side of the station of the Pennsylvania ad; elevation, 27.82 feet. This bench mark is No. 9 of the ylvania Railroad and has an elevation of 72.69 feet above sea The bridge to which this gage was attached was carried away flood of October 10–11, 1903. After that date and until July 04, gage heights were read from a temporary gage on one of ers. On the latter date a standard chain gage was attached to w steel bridge which occupies the site of the old toll bridge and the same datum as the original chain gage; length of chain, feet. At the time this gage was installed a second bench mark ablished on *the top of the bolt* in the fifth course below the

coping on the upstream face of the left abutment; elevation, 14.82 feet. Measurements are made from the lower side of the bridge. The initial point for soundings is on the left bank. The channel above and below is straight. The current is sluggish for a short distance near the left bank. The bed is of gravel and sand and does not change. A dam, located about a mile below the station, may change slowly and thus affect in time the stage of water at the station. The gage is read twice daily by Charles H. Naylor, collector of tolls.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Delaware River at Lambertville, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 22	R. J. Taylor	910	3,614	0.90	2.98	3,249
November 7	E. C. Murphy	1,030	4,747	1.33	3.94	6,305

Mean daily gage height, in feet, of Delaware River at Lambertville, N. J., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	5.45	3.85	3.20	3.10	3.80	3.10	3.65	4.35	4.00
2	.....	.....	.....	8.05	3.75	3.20	3.50	3.55	3.05	3.60	4.20	4.10
3	.....	(a)	(b)	7.80	3.45	3.20	3.35	3.40	3.05	3.90	4.10	4.05
4	.....	.....	.....	6.50	3.10	3.05	3.25	3.30	3.10	3.75	4.05	3.95
5	(a)	c 7.30	.....	5.30	2.95	2.90	3.10	3.55	3.05	3.55	3.95	3.90
6	.....	c 6.30	.....	4.95	2.85	2.95	3.05	3.60	3.00	3.50	4.00	3.75
7	.....	.....	5.30	4.75	2.65	3.05	3.00	3.40	3.10	3.40	3.90	3.80
8	.....	(a)	9.45	4.85	2.60	2.80	3.45	3.30	3.20	3.40	3.80	3.65
9	.....	.....	7.70	5.30	2.50	2.70	4.20	3.35	3.00	3.40	3.80	3.55
10	(a)	7.00	8.05	5.60	2.50	3.10	4.00	3.30	2.95	3.30	3.70	3.60
11	.....	8.30	6.40	5.65	2.55	3.25	3.70	4.10	3.20	3.20	3.70	(a)
12	.....	.....	5.20	5.10	2.65	3.15	3.55	3.45	2.95	3.90	3.70	.....
13	.....	(a)	4.55	4.60	2.60	2.85	3.70	3.95	2.80	3.70	3.80	.....
14	.....	.....	4.15	4.15	2.60	2.70	3.50	4.15	3.50	3.90	4.40	.....
15	(a)	7.90	3.80	3.85	2.65	2.65	3.00	3.80	6.95	4.20	4.35	.....
16	.....	.....	3.75	3.50	2.80	2.50	3.00	3.45	5.15	4.30	4.25	.....
17	.....	.....	3.45	3.35	2.80	2.40	3.00	3.25	4.75	4.05	4.20	.....
18	.....	(a)	3.40	3.05	3.05	2.30	3.05	3.15	4.60	3.90	4.10	.....
19	.....	.....	3.40	3.00	3.25	2.20	3.40	3.05	4.20	3.75	4.05	.....
20	(a)	.....	3.85	2.90	3.35	2.20	3.40	3.40	3.90	3.60	4.00	.....
21	.....	d 10.00	3.85	2.90	3.35	2.20	3.00	3.95	3.60	4.85	3.90	.....
22	.....	d 15.05	3.95	2.85	3.35	2.10	3.20	3.95	3.50	7.60	4.05	.....
23	e 5.00	d 13.50	4.25	2.70	3.20	2.00	2.80	4.30	3.35	9.15	4.40	.....
24	e 4.45	d 11.75	4.20	2.60	2.95	2.00	2.80	4.05	3.20	7.10	4.70	.....
25	e 4.30	.....	5.75	2.50	2.85	2.00	2.75	4.20	3.20	6.25	4.60	.....
26	e 5.00	.....	f 6.45	2.50	2.80	2.00	2.80	4.00	3.10	5.60	4.55	.....
27	.....	.....	f 9.75	2.80	3.20	2.80	2.95	3.65	3.10	5.20	4.45	.....
28	.....	(b)	8.30	3.15	3.50	2.80	3.45	3.55	3.75	5.00	4.30	.....
29	(a)	.....	6.20	3.60	3.35	2.80	3.40	3.40	3.70	4.80	4.20	e 7.
30	.....	.....	5.15	3.95	2.95	2.90	3.45	3.30	3.75	4.70	4.00	9.
31	.....	.....	4.80	.....	3.15	.....	4.10	3.20	.....	4.50	.....	5.

a River frozen at pier. From January 1 to 23 frozen across.
b Ice jam at pier February 25 to March 7.
c Ice jam three-fourths mile below bridge is cause of rise.
d Ice jam cause of rise.
e River open.
f Upper Delaware ice cause of ri[illegible]

LEHIGH RIVER NEAR SOUTH BETHLEHEM, PA.

This station, which was established September 22, 1902, by Prof. ansfield Merriman, of Lehigh University, is located at New Street idge, between Bethlehem and South Bethlehem, Pa. The standard ain gage is attached to the hand rail near the right bank on the ver side of the bridge. The length of chain from the end of the ight to the marker is 43.77 feet. The datum of the gage is referred bench mark No. 72 of the Lehigh Valley Railroad, which is an iron ı set in the south pier of New Street Bridge; elevation, 22.32 feet. is bench mark is 232.87 feet above sea level. Discharge measure-ents are made from the bridge to which the gage is attached. This idge has nine spans, but the river is confined to three, except at high ges. The right bank is high and will not overflow, but on the left nk the river overflows at high stages and joins Monocacy Creek, ich is tributary to Lehigh River a few rods below the station. The tial point for soundings is the face of the pier on the right bank. e channel is straight for several hundred feet above and below the tion. The bed is composed of sand and gravel, which is free from getation and is permanent. The velocity is fair. The gage is read ce daily by Harry E. Edmonds.

The observations at this station during 1904 have been made under e direction of N. C. Grover, district hydrographer.

Discharge measurements of Lehigh River near South Bethlehem, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
uly 21	R. J. Taylor		760	1.10	2.29	838
November 7	H. D. Comstock	293	923	1.38	2.69	1,276

Mean daily gage height, in feet, of Lehigh River near South Bethlehem, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	3.00	3.30	6.60	3.00	2.80	2.60	2.50	2.20	2.40	2.80	2.8
2	2.80	2.80	3.40	6.75	3.00	2.80	2.50	2.40	2.20	2.30	2.80	2.7
3	2.50	2.80	4.00	5.70	2.90	3.00	2.40	2.60	2.30	2.30	2.80	2.
4	2.90	2.70	4.52	4.70	2.80	2.70	2.30	2.70	2.10	2.30	2.70	2
5	2.70	2.80	3.50	4.50	2.80	3.20	2.20	2.60	2.20	2.30	2.70	2
6	2.70	2.90	3.50	4.30	2.70	3.20	2.10	2.50	2.10	2.30	2.70	2
7	2.70	2.90	10.26	4.30	2.60	3.10	2.60	2.30	2.20	2.30	2.70	2
8	2.80	4.10	9.15	4.30	2.60	3.00	3.95	2.40	2.10	2.30	2.60	2
9	2.70	3.90	6.60	4.40	2.60	3.10	3.10	2.40	2.10	2.30	2.60	2
10	2.60	3.50	5.80	4.30	2.60	3.90	3.10	2.40	2.40	2.30	2.60	2
11	2.60	3.10	5.30	4.00	2.70	.....	2.90	3.00	2.20	2.30	2.60	2
12	2.70	3.00	4.60	3.90	2.60	.....	2.70	2.60	2.10	2.50	2.60	2
13	2.80	2.90	4.30	3.80	2.40	3.80	2.70	2.40	2.10	2.70	2.60	2
14	2.80	2.80	4.10	3.70	2.40	.....	2.55	2.40	2.35	2.70	3.20	2
15	2.70	2.80	4.00	3.50	.....	3.10	2.30	2.50	3.50	2.70	3.20	2
16	2.60	2.80	3.90	3.40	3.00	3.00	2.25	2.40	3.70	2.60	3.10	2
17	2.50	2.70	3.70	3.30	2.80	2.90	2.20	2.30	3.20	2.60	2.90	2
18	2.40	2.70	3.70	3.20	2.70	2.70	2.40	2.30	2.80	2.50	2.80	2
19	2.40	2.60	3.60	3.10	2.70	2.60	2.70	2.20	2.80	2.40	2.80	2
20	2.70	2.60	4.30	3.10	2.70	2.50	2.60	2.40	2.70	2.40	2.70	2
21	2.40	2.60	4.30	3.10	2.60	2.50	2.20	3.15	2.60	2.50	3.20	2
22	2.80	6.53	4.20	3.10	2.60	2.50	2.20	2.90	2.60	6.30	3.10	2
23	6.40	4.65	4.30	3.00	2.50	2.50	2.10	3.00	2.50	4.70	3.10	2
24	5.40	4.30	4.40	3.00	2.50	2.40	2.30	2.80	2.50	4.10	3.00	2
25	4.15	4.10	4.70	2.90	2.50	2.40	2.40	2.60	2.30	3.80	2.90	2
26	3.80	3.30	5.30	2.90	2.60	2.40	2.60	2.50	2.30	3.60	2.80	2
27	3.70	3.25	5.10	3.00	2.70	2.30	3.60	2.40	2.30	3.40	2.80	2
28	3.30	3.10	4.90	3.20	2.60	2.20	3.20	2.30	2.30	3.20	2.80	2
29	3.30	3.30	4.30	3.20	2.40	2.35	3.00	2.30	2.30	3.10	2.80	2
30	3.20	.....	4.10	3.10	2.40	2.60	2.80	2.30	2.50	3.00	2.80	2
31	3.10	.....	4.10	.....	2.80	.....	2.60	2.20	.....	2.90	.....	2

MUSCONETCONG RIVER NEAR BLOOMSBURY, N. J.

This station was established July 4, 1903, by E. P. Roundey. It located at the first highway bridge over Musconetcong River abo the village of Bloomsbury, N. J. The 1903 gage was a vertical by 6-inch cypress board spiked to the right abutment near the dow stream end. It read from 0 to 10 feet, and was graduated with g vanized-iron staples. A standard chain gage was installed at tl station on April 12, 1904, by F. H. Tillinghast to the same dat as the staff gage; length of chain, 12.46 feet. The bench mark is square chiseled on the top of the right abutment at its downstre end. Its elevation is 9.63 feet above the gage datum. Dischar measurements are made from the downstream side of the two-sp highway bridge to which the gage is attached. The initial point f soundings is the end of the hand rail on the right bank. The cham is straight for 200 feet above and 100 feet below the station. T current is swift, and both banks are low and liable to overflow. T

bed of the stream is composed of gravel. The channel is broken by the central pier of the two-span bridge, and at high stages part of the water flows around the bridge. Gage readings are taken twice each day by Michael Kieffer.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Musconetcong River near Bloomsbury, N. J., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 7	J. C. Hoyt	64	118	1.56	1.48	184
July 23	R. J. Taylor	64	119	.80	1.14	95
August 24	J. C. Hoyt	64	100	1.07	1.22	106
November 8	H. D. Comstock	60	108	1.35	1.29	147

Mean daily gage height, in feet, of Musconetcong River near Bloomsbury, N. J., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.75	1.72	1.78	.....	1.55	1.31	1.13	1.18	1.05	1.10	1.30	1.48
2	1.68	1.60	1.80	.....	1.51	1.25	1.15	1.08	.95	1.08	1.25	1.25
3	[a] 2.18	1.72	2.55	.....	1.41	1.28	1.08	1.08	.95	1.15	1.25	1.42
4	2.42	1.70	1.98	.....	1.38	1.28	1.03	1.05	1.00	1.10	1.30	1.48
5	2.20	1.68	1.82	(b)	1.33	1.28	1.03	1.90	1.02	1.12	1.28	1.25
6	2.08	1.60	1.75	.....	1.41	1.35	1.03	1.12	1.00	1.12	1.28	1.22
7	1.92	1.85	4.75	.....	1.28	1.38	1.03	1.05	1.00	1.15	1.28	1.25
8	1.68	1.95	.....	.....	1.43	1.31	1.53	1.10	.95	1.18	1.22	1.28
9	1.68	1.65	.....	.....	1.35	1.33	1.48	1.02	1.00	1.15	1.22	1.20
10	1.62	1.65	(b)	(b)	1.33	1.33	1.35	1.08	.90	1.12	1.15	1.20
11	1.60	1.62	.....	.....	1.33	1.28	1.33	1.35	.98	1.08	1.22	1.15
12	1.52	1.55	.....	1.98	1.31	1.25	1.21	1.18	1.10	1.32	1.22	1.28
13	1.62	1.52	.....	1.75	1.31	1.18	1.18	1.12	.90	1.22	1.28	1.25
14	1.82	1.50	.....	1.63	1.28	1.18	1.15	1.18	4.05	1.15	1.55	1.25
15	1.65	1.52	(b)	1.53	1.43	1.13	1.05	1.12	3.35	1.12	1.32	1.25
16	1.58	1.35	.....	1.55	1.41	1.13	1.03	1.08	2.22	1.15	1.45	1.22
17	1.55	2.62	.....	1.55	1.38	1.13	.98	1.08	1.85	1.12	1.40	1.22
18	1.50	1.85	.....	1.58	1.33	1.08	1.11	1.05	1.55	1.08	1.40	1.18
19	1.40	1.40	.....	1.75	1.35	1.08	.98	.98	1.50	1.08	1.32	1.25
20	1.38	1.45	(b)	1.38	1.43	1.11	1.11	1.20	1.32	1.12	1.32	1.22
21	1.50	1.40	.....	1.35	1.31	1.05	1.05	1.28	1.32	2.35	1.40	1.22
22	2.35	[c] 5.58	.....	1.31	1.33	1.05	1.01	1.20	1.25	2.55	1.45	1.20
23	4.55	2.45	.....	1.28	1.28	.93	1.05	1.25	1.20	2.20	1.40	1.20
24	2.70	2.55	.....	1.28	1.25	1.05	1.02	1.20	1.18	1.90	1.40	1.22
25	2.30	1.98	(b)	1.33	1.21	1.11	1.12	1.12	1.18	1.60	1.35	1.20
26	2.05	1.80	.....	1.31	1.23	.93	1.12	1.05	1.20	1.52	1.40	1.22
27	1.98	1.72	.....	1.51	1.23	1.13	1.10	1.05	1.15	1.42	1.32	1.42
28	1.88	1.98	.....	1.63	1.21	1.05	1.10	1.08	1.18	1.40	1.30	1.80
29	1.82	1.78	.....	1.61	1.18	1.18	1.05	1.08	1.12	1.35	1.28	1.58
30	1.78	.....	(b)	1.53	1.13	1.18	1.12	1.02	1.18	1.35	1.40	1.52
31	1.72	.....	.....	.....	1.38	.....	1.08	1.00	.....	1.30	.....	1.45

[a] Ice gorging below. [b] Gage rod washed out. [c] Rain and melting snow causes rise.

TOHICKON CREEK AT POINT PLEASANT, PA.

Tohickon Creek drains an area of 102 square miles in Bucks County, north of Philadelphia. It flows in an easterly course, entering Delaware River about 8 miles above Lambertville, N. J. In a statement by Rudolph Hering, printed in the report of the Philadelphia water department for 1885, page 350, is given a classification of the drainage area of Tohickon Creek, from which it appears that 76 square miles is cultivated and improved and 26 square miles untillable and wooded. Measurements of the discharge of the creek are made near its mouth at Point Pleasant. Rain gages are located within the drainage basin at Quakertown, also at a point about 3 miles north of Bedminster, and near Point Pleasant.

Tables of daily discharge in second-feet, for the years 1883 to 1899 inclusive, are published in Water-Supply Paper No. 47, page 81. Daily records of gage height were not kept during 1900. The following figures of discharge for 1904 were furnished by Mr. John E. Codman, hydrographer of the Water Department of Philadelphia.

Mean daily discharge, in second-feet, of Tohickon Creek at Point Pleasant, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	128	111	247	1,494	68	358	26	27	17	46	33	[illegible]
2	162	107	357	1,215	61	255	29	76	15	38	27	[illegible]
3	162	108	490	304	49	297	23	110	15	31	26	[illegible]
4	169	110	458	166	35	238	12	75	10	35	31	[illegible]
5	177	111	183	111	31	600	11	45	9	27	27	[illegible]
6	169	99	81	85	31	482	12	87	12	21	23	[illegible]
7	154	453	1,616	104	27	1,119	12	38	10	18	23	[illegible]
8	154	685	1,736	133	21	422	151	19	10	16	23	[illegible]
9	154	190	447	270	21	157	74	18	12	14	26	[illegible]
10	154	89	203	307	23	94	81	384	11	15	28	[illegible]
11	142	65	111	173	20	67	79	1,415	7	17	30	[illegible]
12	131	58	74	169	23	56	157	398	4	217	36	[illegible]
13	295	56	57	89	23	44	265	106	10	199	63	[illegible]
14	782	51	58	68	15	33	74	1,331	1,459	106	417	[illegible]
15	1,104	49	55	59	22	23	40	593	4,395	61	440	[illegible]
16	1,144	49	112	49	35	24	28	138	868	45	487	[illegible]
17	798	49	153	44	34	23	23	72	404	39	460	[illegible]
18	454	49	344	42	27	18	19	42	99	35	226	[illegible]
19	241	36	595	39	26	13	20	31	58	29	148	[illegible]
20	158	23	740	39	22	15	26	517	41	33	148	[illegible]
21	131	23	318	35	16	15	33	749	32	2,004	154	[illegible]
22	489	2,090	343	31	14	19	31	286	31	1,035	126	[illegible]
23	3,133	632	425	27	17	47	26	184	31	261	90	[illegible]
24	1,098	272	301	23	15	37	20	119	31	124	76	[illegible]
25	232	218	127	22	10	21	18	59	25	78	67	[illegible]
26	175	128	341	30	10	15	39	43	19	60	58	[illegible]
27	155	76	322	66	9	13	31	34	21	53	45	[illegible]
28	144	39	151	112	8	13	27	26	23	41	44	[illegible]
29	132	173	104	109	7	16	77	27	18	36	49	[illegible]
30	120	.....	82	79	18	25	44	25	49	38	44	[illegible]
31	116	.....	334	.....	715	.....	30	20	.....	36	.....	[illegible]

ated monthly discharge of Tohickon Creek at Point Pleasant, Pa., for 1904.

[Drainage area, 102.2 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	3,133	116	412	4.03	4.65
.....	2,090	23	214	2.09	2.25
.....	1,736	55	354	3.46	3.99
.....	1,494	22	183	1.79	2.00
.....	715	7	46.9	.459	.529
.....	1,119	13	152	1.49	1.66
.....	265	11	49.6	.485	.559
.....	1,415	18	229	2.24	2.58
r.....	4,395	4	258	2.52	2.81
.....	2,004	14	155	1.52	1.75
r.....	487	23	116	1.14	1.27
r	556	17	80.5	.788	.908
e year.....	4,395	4	188	1.83	24.96

NESHAMINY CREEK AT FORKS, PENNSYLVANIA.

drainage basin of Neshaminy Creek is immediately south of Tohickon Creek and of a portion of that of Perkiomen Creek. eam flows in a general southeasterly and southerly course, g Delaware River at a point about 12 miles above Philadelphia. nt of measurement is at the forks of Big and Little Neshaminy

The drainage area at this point is 139 square miles, of which cultivated and improved and 11 miles untillable and wooded. ly discharges from 1884 to 1900 are given in Water-Supply No. 47, pages 90 to 98. The table of daily discharge for 1904 nished by Mr. John E. Codman.

Mean daily discharge, in second-feet, of Neshaminy Creek at forks, Pennsylvania, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	119	144	768	1,549	83	153	26	55	53	47	93	
2	92	135	463	632	72	124	24	79	50	42	85	
3	88	125	369	288	63	113	21	65	52	38	81	
4	88	125	321	195	51	84	18	44	47	37	78	
5	88	125	243	161	47	334	17	34	41	35	75	
6	88	518	80	148	43	414	22	396	38	39	69	
7	88	2,274	3,137	179	40	2,502	118	91	34	33	68	
8	88	864	1,637	194	38	360	1,314	46	29	27	71	
9	92	125	277	513	38	189	149	36	28	29	72	
10	105	125	135	564	39	147	17	1,143	31	30	75	
11	105	125	103	235	38	135	130	1,546	31	33	169	
12	105	115	91	188	35	107	80	256	31	2,577	125	
13	344	89	73	164	34	80	82	243	31	361	408	
14	1,060	72	71	137	33	72	73	1,012	132	167	1,558	
15	955	72	75	118	40	68	43	268	3,911	120	540	
16	532	63	194	104	42	57	39	135	323	101	492	
17	189	54	232	93	37	48	37	102	176	92	419	
18	154	54	755	86	36	45	32	87	135	85	238	
19	125	54	995	85	33	42	31	72	113	77	201	
20	105	63	383	80	33	39	30	1,596	94	72	188	
21	105	118	205	75	33	41	29	482	84	3,560	176	
22	1,592	4,007	385	71	29	94	27	224	76	502	152	
23	4,696	304	473	67	31	80	23	233	68	262	138	
24	1,336	182	253	61	28	33	20	162	59	198	125	
25	380	134	208	63	19	30	22	120	54	174	111	
26	470	105	329	72	20	26	235	97	55	155	105	1
27	450	89	328	103	18	21	203	86	55	136	83	1
28	314	237	181	131	15	22	48	79	51	115	59	1,0
29	213	613	143	117	15	27	48	73	46	105	54	5
30	189	.....	125	98	19	28	37	64	47	101	54	2
31	154	.....	380	.....	246	.....	30	58	.....	97	.....	1

Estimated monthly discharge of Neshaminy Creek at forks, Pennsylvania, for 1904.

[Drainage area, 139 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth i inches
January	4,696	88	468	3.37	3.8
February	4,007	54	383	2.76	2.9
March	3,137	71	433	3.12	3.6
April	1,549	61	219	1.58	1.7
May	246	15	43.5	.320	.3
June	2,502	21	184	1.32	1.4
July	1,314	17	97.6	.702	.8
August	1,596	34	290	2.09	2.4
September	3,911	28	199	1.43	1.6
October	3,560	27	305	2.19	2.5
November	1,558	54	205	1.47	1.6
December	1,090	31	114	.820	.9
The year	4,696	15	245	1.76	23.9

SCHUYLKILL RIVER NEAR PHILADELPHIA.

river receives the drainage of the portion of southeastern ylvania lying between Lehigh River on the north and Susque- River on the south. It flows in a general southeasterly course, ing into Delaware River, the city of Philadelphia being located junction of these streams. Records of the height of the river mount pool have been kept for many years, but not in such as to be useful in computing daily discharges. In 1898, how- careful estimates were prepared by Mr. John E. Codman, in of hydrographic work, Bureau of Water, city of Philadelphia, sults being given in the Twentieth Annual Report, Part IV, 7.

figures for daily discharge in the following table represent the low of the stream, computed from the amount wasted over the ards at Fairmount dam, the pumpage from the river, the leak- nd also the quantity used for power at Fairmount.

following figures for 1904 were furnished by Mr. John E. an:

ily discharge, in second-feet, of Schuylkill River near Philadelphia, Pa., for 1904.

.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1,303	1,445	9,045	6,469	1,292	7,092	771	1,595	994	1,360	1,495	1,258
.....	1,303	1,445	8,934	12,470	1,292	4,294	771	1,595	994	1,360	1,495	1,258
.....	1,303	1,445	6,429	8,434	1,292	5,048	771	1,595	994	1,360	1,495	1,258
.....	1,303	1,445	8,850	5,634	1,292	4,453	771	1,607	994	1,360	1,495	1,258
.....	1,303	1,445	5,129	6,572	1,292	2,991	771	1,595	994	1,360	1,495	1,258
.....	1,303	1,445	3,092	3,391	1,292	4,138	771	1,595	994	1,360	1,495	1,258
.....	1,303	2,439	11,860	3,120	1,292	12,850	771	1,595	994	1,360	1,495	1,258
.....	1,303	6,187	36,180	3,120	1,292	4,136	871	1,595	994	1,360	1,495	1,258
.....	1,303	3,187	14,320	3,484	1,292	3,270	803	1,595	994	1,360	1,495	1,258
.....	1,303	2,024	7,539	4,003	1,292	3,002	771	1,595	994	1,360	1,495	1,258
.....	1,303	1,445	5,299	3,391	1,292	3,630	771	5,339	994	1,360	1,495	1,258
.....	1,303	1,445	3,994	2,887	1,292	2,743	771	3,500	994	4,002	1,495	1,258
.....	1,426	1,445	4,084	2,453	1,292	1,818	771	1,595	994	1,873	1,535	1,258
.....	2,910	1,445	2,755	2,034	1,292	1,730	771	2,568	5,456	1,483	5,173	1,258
.....	3,215	1,445	2,498	2,034	1,292	1,729	771	3,137	29,490	1,360	5,264	1,258
.....	2,064	1,445	2,426	1,866	1,292	1,729	771	1,673	4,044	1,360	3,678	1,258
.....	1,303	1,445	2,483	1,774	1,292	1,729	771	1,595	994	1,360	2,930	1,258
.....	1,303	1,445	3,675	1,774	1,292	1,729	771	1,595	994	1,360	1,857	1,258
.....	1,303	1,445	6,135	1,774	1,292	1,729	771	1,595	994	1,360	2,454	1,258
.....	1,303	1,445	5,925	1,774	1,292	1,729	771	3,354	994	1,360	2,375	1,258
.....	1,303	1,445	4,756	1,774	1,292	1,729	771	3,981	994	11,350	2,375	1,258
.....	3,988	22,810	4,475	1,774	1,292	1,729	771	3,034	994	10,780	2,211	1,258
.....	27,210	21,420	4,650	1,774	1,292	1,729	771	3,679	994	4,927	1,822	1,258
.....	14,050	6,537	3,963	1,774	1,292	1,729	771	3,506	994	2,909	1,671	1,258
.....	7,003	5,058	3,397	1,774	1,292	1,729	771	1,758	994	1,961	1,642	1,258
.....	3,753	4,591	3,585	1,774	1,292	1,501	771	1,595	994	1,419	1,495	1,258
.....	5,369	2,558	3,945	1,774	1,292	1,325	771	1,595	994	1,360	1,495	1,258
.....	1,946	2,654	3,585	1,774	1,432	1,325	803	1,595	994	1,360	1,495	3,531
.....	1,433	4,474	3,061	2,034	1,292	1,325	771	1,595	994	1,360	1,495	4,200
.....	1,303	.....	2,691	1,866	1,292	1,325	771	1,595	994	1,360	1,495	3,063
.....	1,303	.....	3,112	.....	5,997	.....	771	1,595	.....	1,360	.....	3,045

-The above is the *total flow of the river* in second-feet.

Estimated monthly discharge of Schuylkill River near Philadelphia, Pa., for 1904.

[Drainage area, 1,915 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	27,210	1,303	3,196	1.67	1.92
February	22,810	1,445	3,742	1.95	2.10
March	36,180	2,426	6,187	3.23	3.72
April	12,470	1,774	3,218	1.68	1.87
May	5,997	1,292	1,448	.756	.872
June	12,850	1,325	2,901	1.51	1.68
July	871	771	776	.405	.467
August	5,339	1,595	2,176	1.14	1.31
September	29,490	994	2,194	1.15	1.28
October	11,350	1,360	2,278	1.19	1.37
November	5,264	1,495	2,013	1.05	1.17
December	4,200	1,258	1,542	.805	.928
The year	36,180	771	2,639	1.38	18.69

NOTE.—The above is the total flow of the river.

PERKIOMEN CREEK AT FREDERICK, PA.

Perkiomen Creek drains an area lying northwest of the city of Philadelphia. It flows in a southerly direction, emptying into Schuylkill River about 7 miles above Norristown and about 18 miles above Philadelphia. The point of measurement of discharge is located at Frederick about 12 miles above the mouth, and is also above two large tributaries known as West Swamp Creek and Northeast Branch of Perkiomen. Both of these tributaries have been measured—the first at Zieglerville and the second near Schwenkville. The drainage area of the Perkiomen above the point of measurement is given by Rudolph Hering as 152 square miles, of which 111 are cultivated and improved and 41 untillable and wooded. Measurements of this creek were begun on August 20, 1884. Water-Supply Paper No. 35 contains tables of the daily discharge for the entire period from 1884 to 1899, inclusive. The records of daily discharge for 1904, as furnished by Mr. John E. Codman, are given in the following table:

Mean daily discharge, in second-feet, of Perkiomen Creek at Frederick, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	54	121	670	1,763	133	305	203	44	53	82	80	97
2	97	154	613	921	107	398	91	58	46	58	74	92
3	87	119	694	365	93	594	67	106	46	60	68	86
4	133	124	818	252	74	288	45	96	46	65	62	69
5	131	106	211	214	64	503	38	60	46	57	55	78
6	124	88	174	201	62	381	39	269	60	61	51	95
7	126	283	3,581	212	55	2,583	164	126	55	63	59	88
8	128	1,351	2,629	228	53	406	333	63	36	52	67	88
9	126	243	391	279	55	231	157	46	34	46	64	86
10	121	167	216	294	69	183	157	490	33	46	59	78
11	114	114	178	231	70	158	167	1,376	34	54	75	75
12	106	103	152	198	60	131	104	258	47	159	84	75
13	106	103	132	167	52	100	76	130	52	258	147	75
14	765	61	128	138	53	88	72	1,885	1,594	106	634	66
15	537	71	128	118	75	84	63	367	5,460	76	462	72
16	340	118	171	99	123	61	49	172	457	63	451	100
17	233	67	211	98	94	60	45	121	224	59	460	98
18	226	57	299	97	67	64	44	94	148	62	306	82
19	226	55	1,095	92	54	52	50	70	126	61	233	95
20	148	69	892	79	65	55	75	570	100	58	261	102
21	139	79	349	65	69	153	84	768	76	3,821	290	92
22	1,087	3,815	337	61	64	384	61	250	71	820	238	92
23	4,465	563	447	59	65	112	45	334	67	293	194	92
24	671	497	320	60	58	66	42	167	64	202	176	150
25	247	359	256	61	45	45	42	120	58	163	156	214
26	205	189	353	68	35	43	53	92	69	142	128	199
27	224	105	360	130	37	41	128	64	75	124	102	312
28	164	129	228	186	37	40	99	60	70	103	108	1,006
29	116	376	180	183	36	66	66	60	70	87	113	659
30	118	.....	180	163	52	88	62	58	83	80	101	320
31	124	.....	289	.....	1,117	.....	54	58	.....	84	.....	214

Estimated monthly discharge of Perkiomen Creek at Frederick, Pa., for 1904.

[Drainage area, 152 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,465	54	371	2.44	2.81
February	3,815	55	334	2.20	2.37
March	3,581	128	538	3.54	4.08
April	1,763	59	236	1.55	1.73
May	1,117	35	99.8	.657	.757
June	2,583	40	259	1.70	1.90
July	333	38	89.5	.589	.679
August	1,885	44	272	1.79	2.06
September	5,460	33	313	2.06	2.30
October	3,821	46	241	1.59	1.83
November	634	51	179	1.18	1.32
December	1,006	66	163	1.07	1.23
The year	5,460	33	258	1.70	23.07

INDEX.

ıear—
:, N. Y.: Page.
ɔtion 59
N. J.
ɔong River near:
ɔtion 102-103
rge 103
eights 103
.
River near:
ɔtion 84
rge 84
eights 84
N. J.
iver at:
ɔtion 90
rge 90
eights 91
.
ver at:
ɔtion 24-25
rge 25
eights 26
at—
ro, N. Y.:
ɔtion 60
rge 60
rge, mean daily 62
rge, monthly 63
eights 61
table 62
nal feeder at—
s, N. Y.:
rge 73
l.
ver near:
ɔtion 76
rge 76
eights 77
ıt—
ı dam, New York:
ɔtion 71-72
rge, monthly 72
r.
:eservoir near:
ll 44
Brook near:
ɔtion 41-42
rge, mean daily 43
rge, monthly 44
k near:
ɔtion 41-42
rge, mean daily 42
rge, monthly 43

Deerfield reservoir near—
Deerfield, N. Y.: Page.
rainfall 44
Delaware River at—
Lambertville, N. J.:
description 99-100
discharge 100
gage heights 100
Delaware River (East Branch) at—
Hancock, N. Y.:
description 98
discharge 98
gage heights 99
Delaware River (West Branch) at—
Hancock, N. Y.:
description 96
discharge 96
gage heights 97
Delaware River drainage basin:
description 94-95
Dolgeville, N. Y.
East Canada Creek at:
description 50-51
discharge, mean daily 51-52
discharge, monthly 53
Dunsbach Ferry Bridge, New York.
Mohawk River at:
description 29-30
discharge, mean daily 30-31
discharge, monthly 32
East Canada Creek at—
Dolgeville, N. Y.:
description 50-51
discharge, mean daily 51-52
discharge, monthly 53
Esopus Creek at and near—
Kingston, N. Y.:
description 66-67
discharge 67
discharge, mean daily 69
discharge, monthly 69
gage heights 67
rating table 68
Olivebridge, N. Y.:
description 63
discharge 63
discharge, mean daily 65-66
discharge, monthly 66
gage heights 64
rating table 64
Finderne, N. J.
Raritan River at:
description 87-88
discharge 88

Finderne, N. J.—Continued.
Raritan River at—Continued. Page.
discharge, monthly 89
gage heights 88
rating table 89
Fort Edward, N. Y.
Hudson River at:
description 19-20
discharge, mean daily 20-21
discharge, monthly 22
Frederick, Pa.
Perkiomen Creek at:
description 108
discharge, mean daily 109
discharge, monthly 110
Glens Falls, N. Y.
Champlain Canal feeder at:
discharge 73
Graefenberg Creek near—
New Hartford, N. Y.:
description 39
rainfall 40
Graefenberg reservoir near—
New Hartford, N. Y.:
rainfall 40
Hancock, N. Y.
Delaware River (East Branch) at:
description 98
discharge 98
gage heights 99
Delaware River (West Branch) at:
description 96
discharge 96
gage height 97
Hoosic River at—
Buskirk, N. Y.:
description 24-25
discharge 25
gage heights 26
Hudson River at—
Fort Edward, N. Y.:
description 19-20
discharge, mean daily 20-21
discharge, monthly 22
Mechanicsville, N. Y.:
description 22-23
discharge, mean daily 23
discharge, monthly 23
Indian Lake, New York.
Indian River at:
description 24
stage of water 24
Indian River at—
Indian Lake, New York:
description 24
stage of water 24
Johnston Brook near—
Deerfield, N. Y.:
description 41-42
discharge, mean daily 43
discharge, monthly 44
Kingston, N. Y.
Esopus Creek at:
description 66-67
discharge 67
discharge, mean daily 69
discharge, monthly 69
Kingston, N. Y.—Continued.
Esopus Creek at—Continued. Page.
gage heights 67
rating table 68
Lambertville, N. J.
Delaware River at:
description 99-100
discharge 100
gage heights 100
Lehigh River near—
South Bethlehem, Pa.:
description 101
discharge 101
gage heights 102
Little Falls, N. Y.
Mohawk River at:
description 26-27
discharge, mean daily 27-28
discharge, monthly 28-29
Mahwah, N. J.
Ramapo River near:
description 79-80
discharge 80
discharge, monthly 81-82
gage heights 80
rating table 81
Mechanicsville, N. Y.
Hudson River at:
description 22-23
discharge, mean daily 23
discharge, monthly 23
Millington, N. J.
Passaic River at:
description 74
discharge 74
gage heights 75
Millstone, N. J.
Millstone River at:
description 93
discharge 93
gage heights 94
Millstone River at—
Millstone, N. J.:
description 93
discharge 93
gage heights 94
Mohawk River at—
Dunsbach Ferry Bridge, New York:
description 29-30
discharge, mean daily 30-31
discharge, monthly 32
Little Falls, N. Y.:
description 26-27
discharge, mean daily 27-28
discharge, monthly 28-29
Musconetcong River near—
Bloomsbury, N. J.:
description 102-103
discharge 103
gage heights 103
Nail Creek at—
Utica, N. Y.:
description 45-46
discharge, mean daily 46
discharge, monthly 46

ahaminy Creek at—
Forks, Pennsylvania: Page.
description 105
discharge, mean daily 106
discharge, monthly 106
ew Hartford, N. Y.
Graefenberg Creek near:
description 39
Graefenberg reservoir near:
rainfall 40
Starch Factory Creek near:
description 35
discharge, mean daily 36
discharge, monthly 37
Sylvan Glen Creek near:
description 37
discharge, mean daily 38
discharge, monthly 39
: Mile Creek near—
Oriskany, N. Y.:
discharge 73
Croton dam, New York
Croton River at:
description 71-72
discharge, monthly 72
ebridge, N. Y.
Esopus Creek near:
description 63
discharge 63
discharge, mean daily 65-66
discharge, monthly 66
gage heights 64
rating table 64
kany, N. Y.
Nine Mile Creek near:
discharge 73
Oriskany Creek near:
description 32-33
discharge 33
discharge, mean daily 34
discharge, monthly 35
gage heights 33-34
skany Creek near—
Oriskany, N. Y.:
description 32-33
discharge 33
discharge, mean daily 34
discharge, monthly 35
gage heights 33-34
aic River at and near—
Chatham, N. J.:
description 76
discharge 76
gage heights 77
Millington, N. J.:
description 74
discharge 74
gage heights 75
aic River drainage basin
description 73-74
erkiomen Creek at—
Frederick, Pa.:
description 108
discharge, mean daily 109
discharge, monthly 110
hiladelphia, Pa.
Schuylkill River near:
description 107
Philadelphia, Pa.—Continued.
Schuylkill River near—Continued. Page.
discharge, mean daily 107
discharge, monthly 108
Pluckemin, N. J.
Raritan River (North Branch) near:
description 91-92
discharge 92
gage heights 92
Point Pleasant, Pa.
Tohickon Creek at:
description 104
discharge, mean daily 104
discharge, monthly 105
Pompton Plains, N. J.
Pompton River at:
description 78
gage heights 79
Pompton River at—
Pompton Plains, N. J.:
description 78
gage heights 79
Prattsville, N. Y.
Batavia Kill near:
description 59
Schoharie Creek at:
description 54
discharge 54
discharge, mean daily 57-58
discharge, monthly 59
gage heights 55
rating table 56
Ramapo River near—
Mahwah, N. J.:
description 79-80
discharge 80
discharge, monthly 81-82
gage heights 80
rating table 81
Raritan River at—
Bound Brook, N. J.:
description 90
discharge 90
gage heights 91
Finderne, N. J.:
description 87-88
discharge 88
discharge, monthly 89
gage heights 88
rating table 89
Raritan River (North Branch) near—
Pluckemin, N. J.:
description 91-92
discharge 92
gage heights 92
Raritan River (South Branch) at—
Stanton, N. J.:
description 85-86
discharge 86
discharge, monthly 87
gage heights 86
rating table 87
Raritan River drainage basin:
description 84-85
Reels Creek near—
Deerfield, N. Y.:
description 41-42

Reels Creek near—Continued.
Deerfield, N. Y.—Continued. Page.
discharge, mean daily..... 42
discharge, monthly 43
Rockaway River near—
Boonton, N. J.:
description 84
discharge..... 84
gage heights..... 84
Savage reservoir near—
Utica, N. Y.:
rainfall 41
Schoharie Creek at—
Prattsville, N. Y.:
description 54
discharge..... 54
discharge, mean daily..... 57–58
discharge, monthly..... 59
gage heights 55
rating table 56
Schuylkill River near—
Philadelphia, Pa.:
description 107
discharge, mean daily..... 107
discharge, monthly 108
South Bethlehem, Pa.—
Lehigh River near:
description 101
discharge..... 101
gage heights 102
South Cairo, N. Y.
Catskill Creek at:
description 60
discharge..... 60
discharge, mean daily..... 62
discharge, monthly 63
gage heights..... 61
rating table 62
Stanton, N. J.
Raritan River (South Branch) at:
description 85–86
discharge..... 86
discharge, monthly 87
gage heights 86
rating table 87
Starch Factory Creek near—
New Hartford, N. Y.:
description 35
discharge, mean daily..... 36
discharge, monthly..... 37
Sylvan Glen Creek near—
New Hartford, N. Y.
description .....
discharge, mean daily.....
discharge, monthly .....
Tohickon Creek at—
Point Pleasant, Pa.:
description .....
discharge, mean daily.....
discharge, monthly .....
Twin Rock Bridge, N. Y.
West Canada Creek at:
description .....
discharge.....
discharge, mean daily .....
discharge, monthly.....
gage heights .....
Utica, N. Y.
Nail Creek at:
description .....
discharge, mean daily.....
discharge, monthly .....
Savage Reservoir near:
rainfall.....
Wanaque, N. J.
Wanaque River at:
description .....
discharge.....
gage heights.....
Wanaque River at—
Wanaque, N. J.:
description .....
discharge.....
gage heights.....
Wappinger Creek near—
Wappinger Falls, N. Y.:
description .....
discharge.....
gage heights.....
Wappinger Falls, N. Y.
Wappinger Creek near:
description .....
discharge.....
gage heights.....
West Canada Creek at—
Twin Rock Bridge, N. Y.:
description .....
discharge.....
discharge, mean daily.....
discharge, monthly .....
gage heights.....

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PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 125.]

The publications of the United States Geological Survey consist of (1) Annual eports; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral esources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of nited States, folios and separate sheets thereof; (8) Geologic Atlas of United ates, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publica-on; the others are distributed free. A circular giving complete lists may be had application.

Most of the above publications may be obtained or consulted in the following ays:

1. A limited number are delivered to the Director of the Survey, from whom they ay be obtained, free of charge (except classes 2, 7, and 8), on application.
2. Every member of Congress is allotted a certain number, from whom they may e obtained, free of charge, on application.
3. Other copies are deposited with the Superintendent of Documents, Washington, . C., from whom they may be had at practically cost.
4. Copies of all Government publications are furnished to the principal public braries in the large cities throughout the United States, where they may be onsulted by those interested.

The Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of ubjects, and the total number issued is large. They have therefore been classified nto the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports.

Series P.—The hydrographic progress reports contain the results of stream measurements. A report is issued for every calendar year, containing the results of data collected during that year. These reports were first published as a part of the Director's annual report or as a bulletin; they are now published as water-supply and irrigation papers. The following is a list, by years, of the publications containing the progress reports of stream measurements. A detailed index of these reports (1888-1903) is published as Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28, Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39, Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52, Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.

1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124, 125, 126, 127, 128, and 129.
West of Mississippi River, Water-Supply Papers Nos. 130, 131, 132, 133, 134, and 135.

The Geological Survey and the Reclamation Service have suboffices in different parts of the United States, from which hydrographic and reclamation work in the respective localities is carried on and where data may be obtained on application. These offices are located as follows:

Boston, Mass., 6 Beacon street; Utica, N. Y., 75 Arcade; Atlanta, Ga., 409 Temple court; Austin, Tex., University of Texas; Chicago, Ill., Federal Building; Belle Fourche, S. Dak.; Cody, Wyo.; Denver, Colo., Chamber of Commerce Building; Salt Lake, Utah; Los Angeles, Cal., 1108 Braly Building; San Francisco, Cal., 422 Merchants' Exchange Building; Phoenix, Ariz.; Carlsbad, N. Mex.; El Paso, Tex.; Billings, Mont.; Great Falls, Mont.; Hazen, Nev.; Boise, Idaho; Spokane, Wash., 6 Peyton Block; Pendleton, Oreg.

Correspondence should be addressed to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

JULY, 1905.

Water-Supply and Irrigation Paper No. 126 Series P, Hydrographic Progress Reports, 31

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

BY

N. C. GROVER and JOHN C. HOYT

PART III.—Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River Drainages

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

ROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART III.

By N. C. Grover and John C. Hoyt.

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ar ending June 30, 1902	100,000
ar ending June 30, 1903	200,000
ar ending June 30, 1904	200,000
ar ending June 30, 1905	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observations.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations; and second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag-line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is swift some appli-

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., February 4, 1905.

SIR: I transmit herewith the manuscript of Part III of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of the Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of the Mississippi River.

The larger part of the original data for this report was collected under the direction of district hydrographer N. C. Grover, who was assisted by H. D. Comstock. The assembling of the data and their preparation for publication were done under the direction of John C. Hoyt, who has been assisted by R. H. Bolster, Robert Follansbee, Willis E. Hall, and A. H. Horton.

I request that this manuscript be published as one of the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

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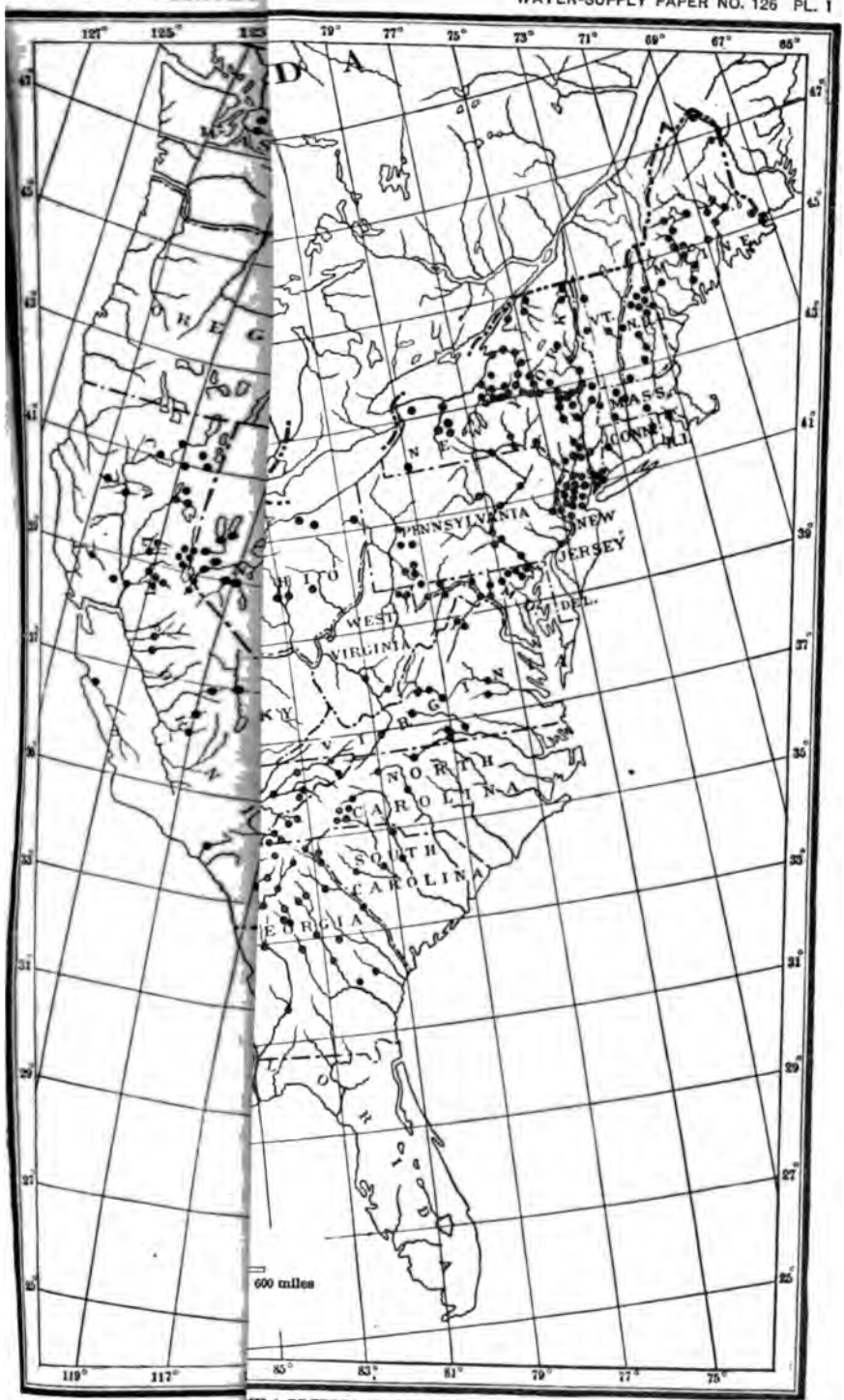

TAINED DURING 1904.

PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

are usually at regular intervals varying from 2 to 20 feet, depending upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity, or at an arbitrary depth, for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenth depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between 94 and 104 per cent, with a mean for the 910 observations of 100 per cent. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from 85 to 95 per cent, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements, or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity-curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth into the area bounded by this mean velocity-curve and the initial line. Owing to the length of time it takes to make these measurements, they

PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

Second-foot is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The acre-foot is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the number of cubic feet of water flowing each second from every square mile of drainage area.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow, into which the element of time does not enter.

The base data for computing the daily discharge of a stream are the various discharge measurements and the daily gage heights, and sufficient discharge measurements should be had to cover the range of gage heights. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights.

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent or practically permanent beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds, the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissas. Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. The mean velocity and area determined for each discharge measure-

nent are also plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mean velocity and the area at various stages as determined by these curves. These curves of mean velocity and area are of special value in determining the location of the rating curve for stages at which actual discharge measurements are not available and for extending the discharge curve outside the limits of the measurements. In the preparation of the rating table the discharge for each tenth or half-tenth on the gage is found from the curve. The first and second differences of these discharges are then taken and adjusted according to the law that they shall either be constant or increasing, never decreasing. The discharges in the table are then changed in accordance with these adjusted differences. In making up the station-rating curve, the individual discharge measurements and the conditions under which they were taken are carefully studied, in order that proper weight shall be given to each measurement. Rating curves in general take the form of a parabola, and as a rule the high-water portion of the curve approaches a straight line. For stations of permanent character, the results of the measurements from year to year should be within 5 per cent of the curve, with the exception of those taken during high water, when the probable error may be as high as 10 per cent.

The determination of the daily discharge of streams with changeable beds is difficult, and unless frequent discharge measurements are made, the results obtained are only roughly approximate. For streams with continually shifting beds, such as Colorado River and Rio Grande, discharge measurements are made every two or three days, and the discharges for the intervening days are obtained by interpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed during floods, station rating curves and tables can be prepared for the periods between changes, and satisfactory results can be obtained with two or three measurements a month, providing measurements are taken soon after the changes occur.

In determining the flow for periods when the streams are frozen, special rating curves and tables have to be prepared from measurements taken under these conditions. The methods of constructing these curves and tables are the same as for open sections. The discharge measurements, however, are taken either by integration in verticals or by vertical velocity-curves, as sufficient experiments have not been made on ice-covered streams to determine the laws which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar year 1904, of which this is Part III, is published in a series of twelve

Water-Supply Papers, Nos. 124–135, inclusive, under the following subtitles:

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha rivers, and Eastern Gulf of Mexico drainage.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meramec, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and the Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainages in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations and such other information that has been collected that has a direct bearing on these data, including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage-heights gives for each day the fluctuations of the surface of the river as found from the mean of the gage readings taken on that day. At most of the stations the gage is read in the morning and in the evening.

'he rating table gives discharges in second-feet corresponding to n stage of the river as given by the gage heights.

n the table of estimated run-off the column headed "Maximum" gives mean flow for the day when the mean gage height was the highest, it is the flow as given in the rating table for that mean gage height. the gage height is the mean for the day, there might have been short iods when the water was higher and the corresponding discharge ger than given in this column. Likewise in the column of "Minim" the quantity given is the mean flow for the day when the mean e height was lowest. The column headed "Mean" is the average r for each second during the month. Upon this the computations the two remaining columns which are defined on page 12 are based.

n the computations for the tables of this report the following gen- l and special rules have been used:

Fundamental rules for computation.

The highest degree of precision consistent with the rational use of time and money nperative.

. All items of computation should be expressed by at least two and by not more n four significant figures.

. Any measurement in a vertical velocity, mean velocity, or discharge curve whose cent of error is 5 times the average per cent error of all the other measurements uld be rejected.

. In reducing the number of significant figures, or the number of decimal places, dropping the last figure, the following rules apply:

a) When the figure in the place to be rejected is less than 5, drop it without chang- the preceding figure. Example: 1,827.4 becomes 1,827.

b) When the figure in the place to be rejected is greater than 5, drop it and increase preceding figure by 1. Example: 1,827.6 becomes 1,828.

c) When the figure in the place to be rejected is 5, and it is preceded by an even ure, drop the 5. Example: 1,828.5 becomes 1,828.

d) When the figure in the place to be rejected is 5, and it is preceded by an odd ure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 28.

. In constructing and applying rating tables a maximum limit of one-half per it error should seldom be exceeded.

Special rules for computation.

. Rating tables are to be constructed as close as the data upon which they are based l warrant. No decimals are to be used when the discharge is over 50 second-feet.

. Daily discharges shall be applied directly to the gage heights as they are tabulated.

. Monthly means are to be carried out to one decimal place when the quantities below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the nthly mean shall be a significant figure. This also applies to the yearly mean.

. Second-feet per square mile and depth in inches for the individual months shall carried out at least to three significant figures, except in the case of decimals, where first significant figure is preceded by one or more naughts (0), when the quantity ll be carried out to two significant figures. Example: 1.25; .125; .012; .0012. The rly means for these quantities are always to be expressed in three significant ures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of these reports is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of the Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of the Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of the Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of the Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of the Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of the Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of the Mississippi River, Water-Supply Papers Nos. 124 to 129 inclusive.
West of the Mississippi River, Water-Supply Papers Nos. 130 to 135 inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at nominal cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the names of the resident hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

Maryland.—Resident hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year, assisted by H. D. Comstock. Acknowledgment is due to the State Geological Survey for cooperation in the work to the extent of paying the observers.

New Jersey.—Resident hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year, assisted by H. D. Comstock.

Pennsylvania.—Resident hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year, assisted by R. J. Taylor and H. D. Comstock. Acknowledgments are due to E. Mather, president of the board of water commissioners, and C. M. Nagle, chief engineer, Harrisburg; James F. Fisher, city engineer of Williamsport, Pa., for cooperation in securing gage heights on Susquehanna River, and Dr. Cary T. Hutchinson, for discharge measurements and records of gage height at McCall Ferry.

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West Virginia.—Resident hydrographer, E. G. Paul in the first half and N. C. Grover in the last half of the year.

SUSQUEHANNA RIVER DRAINAGE BASIN.

Susquehanna River rises in New York and flows southwestward a short distance below the New York-Pennsylvania line, where it turns to the southeast; near Wilkesbarre it again bends to the southwest and flows in this direction as far as Northumberland, where it is joined by the West Branch. Below Northumberland it flows southward and southeastward to Chesapeake Bay. Its total drainage area is about 27,400 square miles, and is larger than that of any other stream on the Atlantic slope of the United States. It is not navigable above the fall line near its mouth.

As the drainage basin embraces such a large area, it is varied in character. In New York the stream, with its tributaries, flows through a rolling and sometimes rather broken country, bounded by a mountainous region on the north. In this part of the course its bed is of gravel or sand, with an occasional rock ledge. Its banks are moderately high and not extensively subject to overflow. In Pennsylvania it enters a mountain region, and its course is in places tortuous as it winds among the parallel ranges. Its bed is generally composed of drift materials, gravel, sand, and bowlders, and its banks are high. Below the mouth of the West Branch the slope becomes more irregular, and at several places there are rapids where the stream flows over a rock bottom. In the lower part of its course, from Marietta to Havre de Grace, the stream occupies a deep, broad valley, varying in width from a few hundred feet to more than a mile. On either shore it is, for the most part, bounded by rocky bluffs and table-lands having elevations from 100 to 500 feet above its waters.

The West Branch has its source in the mountains of Cambria County, Pa., at an elevation of 2,000 feet or more above the sea. It flows generally eastward through Pennsylvania and joins the main stream at Northumberland. Its total drainage area is about 7,030 square miles. In its upper course this tributary drains a mountainous country, while in its middle and lower course the surface is hilly.

Juniata River rises in Center County, Pa., and flows in a southeasterly direction into Susquehanna River 15 miles above Harrisburg. Its drainage basin is mountainous and for the most part covered with forest growth. It has an area of 3,530 square miles.

All available hydrographic data for Susquehanna River basin have been collected and published in Water-Supply Papers 108 and 109. The former of these treats principally of the quality of the water, while the latter gives all data available as to fluctuations in stage and quantity of water flowing.

Water-Supply Paper No. 109 contains records of flow at the gaging stations described in this paper and at the following additional stations:

West Branch at Allenwood, Pa.
Tioughnioga at Chenango Forks, N. Y.
Cayuta at Waverly, N. Y.
Chenango at Oxford, N. Y.
Eaton and Madison brooks at Madison County, N. Y.
Diversions from Chenango River drainage basin.

During 1904 the United States Geological Survey has maintained the following gaging stations in this basin:

Susquehanna at Binghamton, N. Y.
Susquehanna at Wilkesbarre, Pa.
Susquehanna at Danville, Pa.
Susquehanna at Harrisburg, Pa.
Susquehanna at McCall Ferry, Pa.
Chenango at Binghamton, N. Y.
Chemung at Chemung, N. Y.
West Branch at Williamsport, Pa.
Juniata at Newport, Pa.
Broad Creek at Mill Green, Md.
Deer Creek at Churchville, Md.

The United States Weather Bureau maintains river stations in this basin at the following points:

Susquehanna at Towando, Pa.
Susquehanna at Selinsgrove, Pa.
West Branch at Clearfield, Pa.
West Branch at Lock Haven, Pa.
Juniata at Huntingdon, Pa.

SUSQUEHANNA RIVER AT BINGHAMTON, N. Y.

This gaging station was established July 31, 1901. A standard chain gage is attached to the upstream side of the left span of the *Washington* Street Bridge, which is situated about 800 feet upstream

rom the junction of Chenango and Susquehanna rivers. On account of the unfavorable conditions produced by a rift, which extends diagonally across the stream underneath the bridge, discharge measurements are made at Exchange Street Bridge, 1,900 feet upstream. The gage is upstream from the crest of the rift and over a stretch of smooth water extending to the dam, 2,800 feet above. Gage readings are unaffected by backwater from Chenango River at ordinary stages. The bench mark is a chiseled draft on the corner of the left bridge abutment, on the upstream side. Its elevation is 23.71 feet above gage datum. The gage is read twice each day by E. F. Weeks. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Susquehanna River at Binghamton, N. Y., in 1904.

Date.	Hydrogra	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 8	C. C. Covert	3,975	3.58	[a] 11.24	14,254
March 12	do	2,846	2.60	[a] 7.90	7,400
April 8	R. E. Horton	2,524	4.50	6.94	11,118
July 13	C. C. Covert	736	1.07	2.04	786
September 10	do	825	1.29	2.13	1,061
November 21	H. R. Beebe	1,011	2.64	2.86	2,674

[a] Ice gorge causes backwater.

Mean daily gage height, in feet, of Susquehanna River at Binghamton, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	3.28	3.67	3.57	7.72	5.06	2.46	2.02	2.40	2.28	4.12	3.08	2.98
	3.35	3.40	3.29	9.02	4.53	2.48	1.99	2.35	2.25	3.35	3.00	2.82
	[a] 3.42	3.59	3.92	8.00	4.08	2.38	2.14	2.98	2.28	2.90	2.92	2.85
	3.88	3.67	[b] 6.65	6.95	3.68	2.36	2.14	2.95	2.28	2.80	2.88	2.70
	3.52	3.55	8.48	6.20	3.51	2.38	2.06	2.60	2.20	2.68	2.82	2.85
	3.58	3.15	7.68	6.15	3.33	2.41	2.09	3.52	2.22	2.62	2.80	2.68
	3.30	4.42	7.52	6.35	3.13	2.46	2.04	3.40	2.28	2.62	2.92	2.68
	3.28	10.49	11.40	6.98	2.98	2.57	2.04	2.72	2.22	2.52	2.90	2.60
	3.15	11.92	13.62	7.14	2.86	3.67	2.04	2.50	2.22	2.45	2.80	2.60
	3.20	10.85	12.25	8.74	2.80	4.23	2.04	2.38	2.20	2.42	2.75	2.68
	3.10	8.62	9.80	8.24	2.69	3.43	2.04	2.50	2.18	2.40	2.75	2.58
	2.98	7.15	8.02	6.94	2.65	2.93	1.99	2.45	2.18	2.88	2.75	2.98
	2.78	6.03	6.88	6.09	2.65	2.65	2.04	2.30	2.20	5.60	2.70	2.50
	2.72	5.27	6.08	5.51	2.49	2.50	2.02	2.22	2.15	4.68	2.70	2.58
	2.85	4.77	5.30	4.97	2.59	2.43	1.95	2.20	3.00	3.65	2.68	2.58
	3.05	6.12	4.75	4.61	3.22	2.45	1.92	2.28	3.10	3.45	2.70	2.58
	2.85	[b] 6.85	4.28	4.49	3.45	2.33	2.05	2.22	2.82	2.95	2.78	2.60

Anchor ice. January 6, river frozen nearly across.
Heavy anchor ice. River frozen over 2,000 feet downstream from junction of the two rivers. gorge causes backwater March 4-15.

Mean daily gage height, in feet, of Susquehanna River at Binghamton, N. Y., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
18	3.00	6.07	3.85	4.39	3.17	2.33	2.28	2.18	2.55	2.80	2.75	2.40
19	2.98	5.67	3.55	4.49	2.92	2.23	2.10	2.18	2.42	2.70	2.65	2.60
20	3.08	5.22	3.92	4.37	3.22	2.17	2.05	2.22	2.35	2.62	2.65	2.40
21	3.80	4.72	4.45	4.17	3.05	2.20	1.98	2.90	2.30	5.95	2.82	2.45
22	2.78	4.52	4.30	3.97	2.75	2.13	2.00	3.18	2.30	7.48	3.58	2.58
23	7.02	4.92	7.42	3.97	2.67	2.14	1.98	4.55	2.28	6.95	3.72	2.40
24	7.82	5.72	11.40	3.77	2.59	2.09	2.00	4.20	2.18	5.32	3.55	2.35
25	a 8.27	5.52	12.12	3.79	2.62	2.06	2.02	3.38	3.52	4.40	3.38	3.08
26	6.85	4.67	15.92	3.96	2.52	2.02	2.02	2.92	3.25	4.40	3.32	3.15
27	5.95	4.19	15.70	3.93	2.49	1.99	2.05	2.78	3.22	4.35	3.18	3.40
28	5.25	3.75	12.62	b 5.83	2.45	1.99	2.52	2.63	2.85	3.92	2.90	3.80
29	4.42	3.67	8.50	6.36	2.36	2.04	2.58	2.48	2.65	3.65	2.78	3.60
30	4.27	.....	6.90	5.63	2.36	1.99	3.12	2.38	2.80	3.42	2.88	7.05
31	3.89	.....	6.72	.....	2.36	.....	2.65	2.35	.....	3.18	.....	3.5

a Current of stream very sluggish. b Backwater from Chenango River.

Rating table for Susquehanna River at Binghamton, N. Y., for 1901 to 1904, inclusive.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.75	210	3.9	5,255	7.2	15,260	11.6	30,860
1.8	315	4.0	5,510	7.4	15,920	11.8	31,580
1.9	525	4.1	5,770	7.6	16,590	12.0	32,300
2.0	740	4.2	6,030	7.8	17,270	12.2	33,020
2.1	960	4.3	6,300	8.0	17,950	12.4	33,740
2.2	1,180	4.4	6,570	8.2	18,650	12.6	34,470
2.3	1,400	4.5	6,845	8.4	19,350	12.8	35,210
2.4	1,625	4.6	7,125	8.6	20,060	13.0	35,950
2.5	1,855	4.7	7,405	8.8	20,780	13.5	37,820
2.6	2,085	4.8	7,690	9.0	21,500	14.0	39,720
2.7	2,315	4.9	7,980	9.2	22,220	14.5	41,650
2.8	2,545	5.0	8,280	9.4	22,940	15.0	43,600
2.9	2,785	5.2	8,880	9.6	23,660	15.5	45,550
3.0	3,025	5.4	9,495	9.8	24,380	16.0	47,500
3.1	3,265	5.6	10,120	10.0	25,100	16.5	49,500
3.2	3,505	5.8	10,760	10.2	25,820	17.0	51,500
3.3	3,755	6.0	11,400	10.4	26,540	17.5	53,500
3.4	4,005	6.2	12,040	10.6	27,260	18.0	55,500
3.5	4,255	6.4	12,680	10.8	27,980	18.5	57,500
3.6	4,505	6.6	13,320	11.0	28,700	19.0	59,500
3.7	4,755	6.8	13,960	11.2	29,420	19.5	61,500
3.8	5,005	7.0	14,600	11.4	30,140	20.0	63,500

ily discharge, in second-feet, of Susquehanna River at Binghamton, N. Y., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
..	3,705	4,680	4,430	16,930	8,430	1,763	784	1,625	1,356	5,770	3,217	2,977
..	3,880	4,005	3,730	21,500	6,985	1,809	718	1,510	1,290	3,880	3,025	2,593
..	4,055	4,480	5,305	17,950	5,770	1,579	1,048	2,977	1,356	2,785	2,833	2,665
..	5,205	4,680	6,740	14,440	4,705	1,532	1,048	2,905	1,356	2,545	2,737	2,315
..	4,305	4,380	9,815	12,040	4,280	1,579	872	2,085	1,180	2,269	2,593	2,665
..	4,455	3,385	8,410	11,880	3,830	1,648	938	4,305	1,224	2,131	2,545	2,269
..	3,755	6,624	10,100	12,520	3,337	1,763	828	4,005	1,356	2,131	2,833	2,269
..	3,705	26,864	15,070	14,600	2,977	2,016	828	2,361	1,224	1,901	2,785	2,085
..	3,385	32,012	19,100	15,095	2,689	4,680	828	1,855	1,224	1,740	2,545	2,085
..	3,505	28,160	16,600	20,600	2,545	6,165	828	1,579	1,180	1,671	2,430	2,269
..	3,265	20,132	12,190	18,825	2,292	4,080	828	1,855	1,136	1,625	2,430	2,039
..	2,977	15,095	8,970	14,440	2,200	2,857	718	1,740	1,136	2,737	2,430	2,977
..	2,499	11,688	7,140	11,720	2,200	2,200	828	1,400	1,180	10,120	2,315	1,855
..	2,361	9,092	5,860	9,805	1,832	1,855	784	1,224	1,070	7,405	2,315	2,039
..	2,665	7,603	5,000	8,130	2,062	1,694	630	1,180	3,025	4,630	2,269	2,039
..	3,145	11,784	7,545	7,125	3,555	1,740	567	1,356	3,265	4,130	2,315	2,039
..	2,665	14,120	6,300	6,845	4,130	1,466	850	1,224	2,593	2,905	2,499	2,085
..	3,025	11,624	5,130	6,570	3,433	1,466	1,356	1,136	1,970	2,545	2,430	1,809
..	2,977	10,344	4,380	6,845	2,833	1,246	960	1,136	1,671	2,315	2,200	2,085
..	3,217	8,940	5,305	6,435	3,555	1,114	850	1,224	1,510	2,131	2,200	1,625
..	5,005	7,461	6,705	5,900	3,145	1,180	696	2,785	1,400	11,240	2,593	1,740
..	2,499	6,901	6,300	5,432	2,430	1,026	740	3,457	1,400	16,250	4,455	2,039
..	14,666	8,040	15,920	5,432	2,246	1,048	696	6,985	1,356	14,440	4,805	1,625
..	17,338	10,504	30,140	4,930	2,062	938	740	6,030	1,136	9,185	4,380	1,970
..	18,895	9,867	32,660	4,980	2,131	872	784	3,955	4,305	6,570	3,955	3,217
..	14,120	7,321	47,110	5,406	1,901	784	784	2,833	3,630	6,570	3,805	3,385
..	11,240	6,004	46,330	5,330	1,832	718	850	2,499	3,555	6,435	3,457	4,005
..	9,030	4,880	34,470	5,080	1,740	718	1,901	2,154	2,665	5,305	2,785	20,780
..	6,624	4,680	19,700	12,520	1,532	828	2,039	1,809	2,200	4,630	2,499	23,660
..	6,219	.....	14,280	10,280	1,532	718	3,313	1,579	2,545	4,055	2,737	14,765
..	5,230	.....	13,640	.....	1,532	.....	2,200	1,510	.....	3,457	.....	9,034

–On account of backwater from Chenango River and ice gorges, the discharges from March 4 on April 28 are uncertain, and are only estimates.

Estimated monthly discharge of Susquehanna River at Binghamton, N. Y., for 1904.

[Drainage area, 2,400 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	18,895	2,361	5,794	2.41	2.78
February	32,012	3,385	10,530	4.39	4.73
March	47,110	3,730	14,010	5.84	6.73
April	21,500	4,930	10,650	4.44	4.95
May	8,430	1,532	3,088	1.29	1.49
June	6,165	718	1,769	.737	.822
July	3,313	567	1,027	.428	.493
August	6,985	1,136	2,396	.998	1.151
September	4,305	1,070	1,850	.770	.859
October	16,250	1,625	5,016	2.09	2.41
November	4,805	2,200	2,881	1.20	1.34
December	23,660	1,625	4,226	1.76	2.03
The year	47,110	567	5,270	2.20	29.78

SUSQUEHANNA RIVER AT WILKESBARRE, PA.

This gaging station was established by E. G. Paul, March 30, 1899. The standard chain gage is attached to the upstream side of the left span of Market Street Bridge. The length of the chain from the end of the weight to the marker is 40.83 feet. The bench mark is the extreme west end of the stone doorsill of the north entrance to the Coal Exchange Building. Its elevation is 32.99 feet above gage datum.

The Weather Bureau has maintained a gage and has records for this locality since 1888. The datum of that Bureau's gage, which was attached to the left-hand pier, was at the bottom of the dressed-stone portion of the pier, at an elevation reported to be 535 feet above sea level. During low stages of the river the water recedes from the pier, rendering it impracticable to read this gage. On account of the low water, which in 1897 had gone below the city datum, it was decided to put the zero of the new gage 4 feet below the zero of the old Weather Bureau gage, so as to obviate minus readings. In order, therefore, to compare with former records it is necessary to add 4 feet to the old figures. The danger mark of this Weather Bureau gage is at 14 feet (or 18 feet on new gage), as at this elevation the west bank of the river is under water in places.

Discharge measurements are made from the downstream side of the

dge, which has a total span of 700 feet between abutments. The tial point for soundings is at the end of the iron hand rail on the t bank, downstream side. The channel is straight for about one-arth mile above and below the station. There is a bar across the er about one-half mile above the station, and another at about the me distance below, with deep water between these two points. e current is sluggish at low stages. The right bank is low and erflows at a gage height of about 20 feet. The left bank is above dinary floods. The bed of the stream is composed of sand and avel, and is somewhat shifting. There is but one channel, broken three bridge piers. A few willows grow under the right span. ring low water, measurements have been made by wading at a bet-r cross section, at Retreat, 10 miles below Wilkesbarre. The Market reet Bridge is at such an elevation above the river bed that 65 feet cable is needed to sound across the section.

Since the establishment of this station the recorded gage height has d a maximum range of 28.5 feet, and the estimated discharge has en between the extremes of 146,800 and 1,000 cubic feet per second. l records and estimates for this station for years prior to 1905 have en revised and republished in Water-Supply Paper No. 109. The ge is read once each day by W. S. Bennett, the bridge keeper.

Observations of fluctuations of Susquehanna River are made by the eather Bureau above Wilkesbarre, at Towanda, Pa., where the ainage area is estimated to be 8,000 square miles. The river gage, de of iron, 1 foot wide and one-half inch thick, is on the east side the road bridge over Susquehanna River, and is securely bolted to masonry of the pier. The graduation is from 0 to 25 feet. The ghest water was 29 feet, in March, 1869, and the lowest, −0.1 foot, in tober, 1895; the danger line is at 16 feet. The elevation of the ro is 633.7 feet above sea level.

The observations at this station during 1904 have been made under direction of N. C. Grover, district hydrographer.

Discharge measurements of Susquehanna River at Wilkesbarre, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
y 20	N. C. Grover	3,864	1.13	4.05	4,382
y 21[a]	do	4,077	1.15	4.20	4,680
tember 15	John C. Hoyt	3,670	.96	3.70	3,540
tober 1	do	4,220	1.44	4.75	6,090
vember 5	H. D. Comstock	4,218	1.47	4.61	6,189
vember 7	do	4,057	1.39	4.49	5,660

[a] Measured at Pittston.

Mean daily gage height, in feet, of Susquehanna River at Wilkesbarre, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.00	14.00	10.80	12.00	11.50	5.70	3.50	4.80	3.70	4.80	5.30	4.20
2	8.90	13.00	10.90	15.10	10.50	7.40	3.50	4.40	3.60	5.40	5.10	4.10
3	8.50	12.30	11.50	15.80	9.40	7.00	3.50	4.20	3.50	5.90	4.90	4.20
4	7.20	11.60	16.50	14.00	8.40	6.40	3.50	4.30	3.40	5.20	4.80	4.20
5	6.50	11.00	[a] 18.20	12.00	7.60	6.00	3.50	5.30	3.40	4.70	4.60	3.60
6	6.70	[b] 10.90	17.20	10.70	7.00	9.10	3.50	5.00	3.30	4.50	4.50	3.50
7	7.20	11.60	17.90	10.20	6.70	7.40	3.60	4.40	3.30	4.30	4.50	3.50
8	7.20	[c] 21.70	25.20	10.50	6.30	6.40	3.70	4.60	3.30	4.00	4.50	3.40
9	7.30	25.80	[d] 30.60	11.00	6.00	6.60	4.20	5.00	3.50	4.00	4.50	3.30
10	7.40	24.60	26.60	11.70	5.70	11.60	3.80	4.40	3.50	3.90	4.50	3.20
11	7.30	23.80	24.00	16.20	5.50	10.90	3.70	4.60	3.30	3.80	4.40	3.10
12	7.10	22.00	[e] 22.00	14.30	5.20	8.50	4.10	4.00	3.30	3.80	4.40	3.30
13	7.00	20.30	[e] 19.30	12.10	5.00	7.10	4.50	3.90	3.20	3.90	4.30	3.20
14	7.00	[f] 18.00	[e] 17.40	10.80	4.80	6.20	4.20	3.80	3.10	7.00	4.20	3.30
15	6.70	17.00	[e] 15.90	9.70	4.80	5.60	3.90	3.60	3.60	8.30	4.30	3.20
16	6.40	15.70	[e] 14.90	8.90	6.10	5.20	3.80	3.50	5.50	6.90	4.30	3.30
17	6.20	14.70	[e] 14.00	8.30	8.00	5.10	3.60	3.40	4.30	6.00	4.30	3.30
18	6.00	12.90	[e] 13.00	8.00	7.90	5.60	3.90	3.30	4.80	5.50	4.40	3.30
19	[g] 5.90	12.60	[e] 12.50	7.90	7.10	4.80	3.60	3.30	4.40	5.10	4.30	3.30
20	5.60	[h] 12.90	12.80	7.90	11.20	4.50	3.70	3.20	4.10	4.80	4.30	3.40
21	[i] 5.60	12.70	13.60	7.80	10.20	4.30	4.20	3.20	3.80	5.00	4.30	3.40
22	6.00	12.90	10.50	7.40	8.50	4.10	3.80	3.30	3.60	8.60	4.60	3.40
23	12.70	13.70	9.70	7.10	7.30	4.30	3.50	3.70	3.40	10.20	4.60	3.30
24	[j] 18.20	12.80	16.90	7.10	6.50	4.00	3.40	4.90	3.40	10.20	5.30	3.50
25	13.50	12.70	16.30	7.00	6.50	3.90	3.30	6.40	3.40	8.80	5.50	3.60
26	[k] 11.60	12.60	20.40	6.90	6.70	3.80	3.40	5.80	4.00	7.40	5.20	3.30
27	[k] 10.10	12.00	22.90	7.20	6.50	3.70	3.70	5.30	5.40	6.90	5.00	3.50
28	[k] 9.00	12.00	22.70	7.90	5.90	3.50	3.60	4.60	5.30	6.70	4.80	10.00
29	[k] 8.20	11.50	18.40	12.40	6.00	3.50	3.60	4.30	5.20	6.40	4.20	13.75
30	[k] 9.20	.....	14.20	12.80	5.50	3.40	3.80	4.10	4.70	6.00	4.20	13.30
31	13.90	.....	11.70	.....	5.30	.....	4.10	3.90	.....	5.90	.....	10.80

[a] Ice still unbroken.
[b] Closed with anchor ice as far up as Ransom.
[c] Ice started at 5.15 p. m.; moved until February 10, 12 m. Gorged below city.
[d] Highest gage reading 30.60.
[e] Still gorged.
[f] Ice blocked as far as Tunkhannock, Pa.
[g] Ice started at Pittston at 1.30 p. m., at Wilkesbarre, 2 p. m. River closed December 10 to 28, inclusive.
[h] Ice blocked as far as Laceyville, Pa.
[i] 12 midnight, ice still running; stream nearly full.
[j] River full of running ice all day; 10 p. m., very little ice running.
[k] Anchor ice.

ble for Susquehanna River at Wilkesbarre, Pa., from March 30, 1899, to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
620	4.3	5,070	6.6	13,170	9.8	28,200
720	4.4	5,340	6.7	13,590	10.0	29,200
820	4.5	5,620	6.8	14,010	10.2	30,100
930	4.6	5,910	6.9	14,440	10.4	31,100
1,050	4.7	6,210	7.0	14,870	10.6	32,100
1,180	4.8	6,520	7.1	15,300	10.8	33,000
1,320	4.9	6,830	7.2	15,730	11.0	34,000
1,470	5.0	7,150	7.3	16,160	11.2	35,000
1,630	5.1	7,470	7.4	16,600	11.4	36,000
1,810	5.2	7,800	7.5	17,040	11.6	37,000
2,000	5.3	8,140	7.6	17,490	11.8	37,900
2,200	5.4	8,490	7.7	17,950	12.0	38,900
2,410	5.5	8,850	7.8	18,420	12.2	39,900
2,620	5.6	9,210	7.9	18,900	12.4	40,800
2,840	5.7	9,580	8.0	19,380	12.6	41,800
3,070	5.8	9,950	8.2	20,360	12.8	42,800
3,300	5.9	10,330	8.4	21,340	13.0	43,700
3,540	6.0	10,720	8.6	22,320	13.2	44,700
3,780	6.1	11,120	8.8	23,300	13.4	45,700
4,030	6.2	11,520	9.0	24,300	13.6	46,700
4,280	6.3	11,930	9.2	25,300	13.8	47,600
4,540	6.4	12,340	9.4	26,200	14.0	48,600
4,800	6.5	12,750	9.6	27,200		

based on discharge measurements of 1899, 1900, 1901, 1902, 1903, and 1904. ined between 2 feet gage height and 19 feet gage height. Tangent at 8.80 height with a difference of 500 per tenth. Table applied to tenths.

Mean daily discharge, in second-feet, of Susquehanna River at Wilkesbarre, Pa., f

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	24,300	48,600	16,600	38,900	36,500	9,580	3,070	6,520	3,540	6,520	8,14
2	23,800	43,700	16,900	56,000	31,600	16,600	3,070	5,340	3,300	8,490	7,47
3	21,830	40,300	18,350	61,000	26,200	14,870	3,070	4,800	3,070	10,330	6,83
4	15,730	37,000	33,300	48,600	21,340	12,340	3,070	5,070	2,840	7,800	6,52
5	12,750	34,000	40,100	38,900	17,490	10,720	3,070	8,140	2,840	6,210	5,91
6	13,590	33,500	36,100	32,600	14,870	24,800	3,070	7,150	2,620	5,620	5,62
7	15,730	37,000	38,900	30,100	13,590	16,600	3,300	5,340	2,620	5,070	5,62
8	15,730	55,900	74,760	31,600	11,930	12,340	3,540	5,910	2,620	4,280	5,62
9	16,160	75,100	108,700	34,000	10,720	13,170	4,800	7,150	3,070	4,280	5,62
10	16,600	71,300	82,900	37,400	9,580	37,000	3,780	5,340	3,070	4,030	5,62
11	16,160	67,000	68,000	63,900	8,850	33,500	3,540	5,910	2,620	3,780	5,34
12	15,300	57,600	57,600	50,600	7,800	21,830	4,540	4,280	2,620	3,780	5,34
13	14,870	49,400	44,900	39,400	7,150	15,300	5,620	4,030	2,410	4,030	5,07
14	14,870	39,300	36,800	33,000	6,520	11,520	4,800	3,780	2,200	14,870	4,8
15	13,590	35,300	31,100	27,700	6,520	9,210	4,030	3,300	3,300	20,850	5,07
16	12,340	30,350	27,500	23,800	11,120	7,800	3,780	3,070	8,850	14,440	5,0
17	11,520	26,800	31,000	20,850	19,380	7,470	3,300	2,840	5,070	10,720	5,0
18	10,720	21,850	30,000	19,380	18,900	9,210	4,030	2,620	6,520	8,850	5,3
19	10,330	21,050	35,500	18,900	15,300	6,520	3,300	2,620	5,340	7,470	5,0
20	9,210	21,850	42,800	18,900	35,000	5,620	3,540	2,410	4,540	6,520	5,0
21	9,210	21,350	46,700	18,420	30,100	5,070	4,800	2,410	3,780	7,150	5,0
22	10,720	21,850	31,600	16,600	21,830	4,540	3,780	2,620	3,300	22,320	5,9
23	42,300	26,700	27,700	15,300	16,160	5,070	3,070	3,540	2,840	30,100	5,9
24	79,600	21,550	69,200	15,300	12,750	4,280	2,840	6,830	2,840	30,100	8,1
25	46,200	21,350	69,200	14,870	12,750	4,030	2,620	12,340	2,840	23,300	8,8
26	37,000	21,500	98,900	14,440	13,590	3,780	2,840	9,950	4,280	16,600	7,8
27	29,600	19,600	123,400	15,730	12,750	3,540	3,540	8,140	8,490	14,440	7,1
28	24,300	19,600	121,300	18,900	10,330	3,070	3,300	5,910	8,140	13,590	6,5
29	20,360	18,350	81,300	40,800	10,720	3,070	3,300	5,070	7,800	12,340	4,8
30	25,300	.....	49,900	42,800	8,850	2,840	3,780	4,540	6,210	10,720	4,8
31	48,100	.....	37,400	.....	8,140	.....	4,540	4,030	.....	10,330	.....

From February 8 to March 19, 1904, discharges reduced 50 per cent on acc
ice gorge.

ted monthly discharge of Susquehanna River at Wilkesbarre, Pa., for 1904.

[Drainage area, 9,810 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	79,600	9,210	21,860	2.23	2.57
.....	75,100	18,350	35,720	3.64	3.92
.....	123,400	16,600	52,530	5.34	6.16
.....	63,900	14,440	31,290	3.19	3.56
.....	36,500	6,520	15,750	1.61	1.86
.....	37,000	2,840	11,180	1.14	1.27
.....	5,620	2,620	3,636	.371	.428
.....	12,340	2,410	5,194	.529	.610
.....	8,850	2,200	4,119	.420	.469
.....	30,100	3,780	11,260	1.15	1.33
.....	8,850	4,800	5,972	.609	.679
.....	47,850	2,200	7,660	.781	.900
year	123,400	2,200	17,180	1.75	23.76

SUSQUEHANNA RIVER AT DANVILLE, PA.

tation, 52 miles below Wilkesbarre and 11 miles above the f the West Branch, was established on March 25, 1899, by ul. It is located at Mill Street Bridge, 600 feet south of the uare, Danville, Pa., near the Pennsylvania Railroad station, nville.

rch 9, 1904, this bridge was carried away in the ice freshet, that date until the water dropped below gage height, 5 feet, was observed on the Weather-Bureau gage, which is painted er nearest the right bank. After the water fell below 5 feet, tember 30, its stage was observed approximately by means of y gages, which were placed in position by the gage reader, pumping station on the right bank. These were usually set of a carpenter's level and at times were considerably in error. xpected that the new steel bridge will be in such condition chain gage may be replaced early in 1905. The total span 1,300 feet, broken by six bridge piers, which do not obstruct to any considerable extent. The channel is straight for about mile above and below the station. The right bank is liable to in extreme freshets. The bed is rocky, with some gravel, rmanent. The current is good, except at extreme low water. the establishment of the gage the record shows a range in

gage height of nearly 25 feet, and the extremes of high and low water within that period are estimated at 163,000 and 830 cubic feet per second, respectively. The bench mark is the extreme south end of the stone doorsill at the east entrance to the city filtering plant. Its elevation is 31.7 feet above gage datum. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Mean daily gage height, in feet, of Susquehanna River at Danville, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	14.70	11.40	11.05	8.10	4.00	2.00	2.40	1.90	.....	.....	.....
2	(a)	14.10	11.30	10.85	8.00	4.20	2.00	2.50	1.90	.....	.....	.....
3	(a)	13.30	11.80	10.60	7.50	4.70	1.90	2.50	1.80	.....	.....	.....
4	(a)	12.70	a12.90	10.40	6.40	4.20	1.90	2.70	1.70	.....	.....	.....
5	(a)	12.10	13.80	10.40	5.30	4.70	1.80	2.90	1.70	.....	.....	.....
6	(a)	11.70	16.00	9.70	4.20	5.10	2.40	2.50	1.60	.....	.....	.....
7	(a)	11.50	17.25	9.30	3.70	5.50	2.30	2.40	1.50	.....	.....	.....
8	(a)	13.10	19.95	8.80	3.60	4.70	2.10	2.70	1.50	.....	.....	.....
9	(a)	c20.00	b24.00	8.20	3.60	4.30	2.10	2.90	1.40	.....	.....	.....
10	(a)	c23.86	.....	7.90	3.40	4.90	2.00	2.40	1.40	.....	.....	.....
11	(a)	21.25	.....	7.40	3.30	7.10	1.90	1.90	1.40	.....	.....	.....
12	(a)	19.50	.....	6.80	3.30	6.20	1.90	1.70	1.30	.....	.....	.....
13	(a)	18.05	.....	6.30	3.20	4.80	2.00	1.70	1.30	.....	.....	.....
14	(a)	16.90	.....	6.10	3.10	4.70	2.40	1.60	1.60	.....	.....	.....
15	(a)	15.40	.....	5.80	2.90	4.50	2.60	1.60	1.90	.....	.....	.....
16	(a)	f13.90	.....	5.40	2.70	4.30	2.20	1.50	2.20	.....	.....	.....
17	(a)	13.00	.....	5.00	3.90	4.00	1.90	1.40	1.90	.....	.....	.....
18	(a)	12.40	.....	4.70	4.50	3.70	1.80	1.70	1.70	.....	.....	.....
19	(a)	11.00	.....	4.30	6.30	3.30	1.80	1.60	1.60	.....	.....	.....
20	(a)	10.60	.....	4.10	6.90	3.00	1.70	1.50	1.50	.....	.....	.....
21	(a)	11.20	.....	4.00	7.20	2.80	1.70	1.50	1.50	.....	.....	.....
22	(c)	12.30	.....	3.70	6.30	2.60	1.60	1.40	1.90	.....	.....	.....
23	(a)	12.30	.....	3.50	4.90	2.60	1.90	1.40	2.40	.....	.....	.....
24	b19.85	12.40	.....	3.30	4.40	2.50	2.00	1.80	2.90	.....	.....	.....
25	c24.00	12.00	.....	3.30	4.10	2.50	1.80	2.40	2.30	.....	.....	.....
26	23.25	11.70	.....	3.20	4.70	2.30	1.70	2.90	2.00	.....	.....	.....
27	19.85	11.70	14.25	3.00	4.40	2.20	1.50	2.60	2.20	.....	.....	.....
28	17.90	11.40	13.80	4.20	3.90	2.20	1.80	2.50	2.70	.....	.....	.....
29	16.00	11.10	13.35	5.30	3.70	2.10	1.80	2.30	2.10	.....	.....	.....
30	15.55	.....	12.55	6.90	3.70	2.10	2.00	2.00	2.40	.....	.....	.....
31	15.05	.....	11.75	.....	3.90	.....	2.20	1.90	.....	.....	.....	.....

a River frozen.
b The ice started at 11.30 a. m.
c The ice gorged 1 p. m.
d The river is still frozen over.
e The ice broke and gorged and left an open place by the bridge.
f The ice is still gorged in the river.
g The ice gorge is still in the river above and below town.
h The ice started at 4 o'clock and the water backed up to 29 feet.

NOTE.—The gage heights for 1904 are somewhat uncertain, therefore no estimates of flow have been made.

SUSQUEHANNA RIVER AT HARRISBURG, PA.

1890 regular daily observations of the stage of Susquehanna River ırrisburg were started by E. Mather, president of the Harrisburg r Board. These observations have been continued since that and have been furnished to the United States Geolgical Survey ıgh the courtesy of Mr. Mather.

e gage is located in the pump well at the pump house of the city ·works, the well being connected with the river by two large s. The datum of the gage is the low-water mark of 1803, and is ed on a large, sloping rock, about 40 feet from the left bank at low : and about halfway between the Walnut Street Bridge and the ›ing station. The original readings are taken in feet and inches, or convenience in computations have been reduced to feet and s.

e first discharge measurement was made at this station in March, by Mr. E. G. Paul, and measurements have been made here by ıeers of the United States Geological Survey since that date. The uring section is at the lower side of the Walnut street toll bridge, hich point the river is divided into two channels by Fosters d, which is here about 1,200 feet wide. This island has low and ng banks, and during extreme floods is completely overflowed.

ordinary stages the left channel is 1,350 feet wide, broken by ridge piers; the right channel is 1,300 feet wide, broken by seven . The banks of the river are high. The bed is composed of hard rial and is permanent, except in the spans adjacent to the island. ·elocity never becomes too sluggish to measure. The initial point ›undings is the upright at the end of the handrail on the down- m side at the left bank.

ıring the spring and summer of 1903 a new bridge was built across ıchanna River at Market street, which is about 1,200 feet below aging station. The piers of this new bridge obstruct the channel e river by between 10 and 15 per cent of the total cross section. e latter part of 1903 and early in 1904 the old piers on this site removed, so that the river channel was left in such condition the effect on the stage of the river at Walnut Street Bridge ined practically unchanged.

the summer of 1904 certain changes and improvements were made › pumping station, and a partial dam was made in the river just ; the pumping station. The effect of this dam was to raise the ·ent stage of the water at the gage.

July 18, 1904, a standard chain gage was attached to the guard n the upstream side of Walnut Street Bridge in the left-hand The datum of this gage is also the low-water mark of 1803, and ›elieved that it records truly the stage of the river to that datum,

and that the changes in bridges below or in the pumping station above do not appreciably affect the records obtained from it.

The length of chain is 39.38 feet. The datum is referred to a bench mark on the left abutment at the top upstream outer corner of the bridge seat; elevation, 32.99 feet.

Observations at the gage in the pumping station are made by the engineer, C. M. Nagle, each morning before starting the pumps. Observations at the standard chain gage are made by Thomas Numbers, toll collector, once daily. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Minimum, maximum, and mean discharge of Susquehanna River at Harrisburg, Pa., for 1891 to 1904, inclusive.

Year.	Minimum.			Maximum.			Mean discharge.
	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	
		Feet.	*Sec.-feet.*		*Feet.*	*Sec.-feet.*	*Sec.-feet.*
1891	Oct. 4–7, inclusive.	1.60	10,200	Feb. 19	19.00	334,500	52,200
1892	Oct. 31–Nov. 8, inclusive.	.50	4,070	Apr. 6	14.65	224,200	37,250
1893	Aug. 16–19, inclusive, 25.	.35	3,500	May 6	16.50	267,400	40,550
1894	Sept. 5–6	.25	3,160	May 22	25.60	543,500	39,970
1895	Oct. 30–31	.05	2,570	Apr. 11	13.65	205,400	29,330
1896	Sept. 5–13	.25	3,160	Apr. 1–2	14.60	223,200	34,600
1897	Sept. 15, Oct. 21	.50	4,070	Mar. 26	11.50	165,306	32,320
1898	Oct. 3–7	.65	4,740	Mar. 24	15.65	245,900	40,490
1899	Oct. 24 and 25	.15	2,850	Mar. 7	13.00	193,000	31,000
1900	Sept. 28 and 29	—.04	2,360	Mar. 2	13.10	194,900	29,950
1901	Nov. 12	1.00	6,550	Dec. 16	21.40	405,100	42,380
1902	Sept. 23, 24, 25	.85	5,760	Mar. 2	23.90	484,100	47,100
1903	Oct. 7	1.40	8,850	do	16.85	276,500	54,510
1904		0.84	5,708				32,318
For the 14 years.	Sept. 28–29, 1900	—.04	2,360	May 22, 1894.	25.60	543,500	38,855

Discharge measurements of Susquehanna River at Harrisburg, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
rch 9	Tillinghast and Sawyer	40,670	6.2	15.6	[a]261,860
y 15	N. C. Grover	11,870	2.22	3.08	26,408
tember 13	J. C. Hoyt	6,646	.90	1.10	5,950
tember 29	do	8,730	1.34	1.78	11,660
tober 1	N. C. Grover	8,460	1.48	1.85	12,560
vember 4	Hoyt and Comstock	8,972	1.39	1.82	12,600

[a] River running full of ice. Measurement approximate.

Mean daily gage height, in feet, of Susquehanna River at Harrisburg, Pa., for 1904.[a]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	2.16	4.41	9.41	6.40	7.65	3.65	1.90	1.58	1.48	1.78	2.08	1.79
	2.16	4.16	11.50	10.15	6.65	3.90	1.73	1.68	1.28	1.68	1.98	1.54
	4.00	4.00	11.91	13.06	6.40	4.23	1.98	1.93	1.23	1.53	1.88	1.44
	3.16	4.75	18.50	11.15	5.65	4.23	1.90	1.93	1.23	1.78	1.78	1.24
	3.16	3.41	22.00	9.40	4.90	3.98	1.65	1.88	1.18	1.93	1.68	1.29
	2.91	4.41	19.41	7.73	4.06	4.90	1.73	1.78	1.13	1.73	1.64	.94
	2.91	3.75	16.33	6.73	3.98	5.23	1.73	2.08	1.08	1.58	1.60	1.29
	2.83	3.83	21.16	6.15	3.81	4.73	2.23	2.03	.98	1.48	1.54	1.09
	2.83	5.50	15.91	6.06	3.48	3.98	2.56	1.78	.98	1.38	1.54	1.24
	[b]2.83	9.08	15.00	6.40	3.40	3.56	2.56	1.68	1.18	1.23	1.49	1.19
	3.00	9.33	12.00	8.48	3.15	4.31	4.48	1.88	1.18	1.18	1.59	.84
	3.58	8.41	9.16	9.15	2.98	5.40	5.06	1.63	1.18	1.23	1.54	.94
	3.83	9.91	7.91	7.98	2.90	4.65	4.40	1.58	1.13	1.23	1.59	1.69
	4.91	13.50	6.58	7.15	2.56	3.90	3.73	1.48	1.08	1.23	1.69	1.44
	4.66	12.50	6.08	6.31	2.81	3.23	3.23	1.33	1.38	1.38	1.64	1.49
	4.50	11.58	5.58	5.25	3.15	2.90	2.90	1.33	1.58	2.93	1.59	1.39
	5.00	10.16	5.25	5.15	3.40	2.65	2.56	1.28	1.98	2.73	1.54	1.30
	5.00	9.91	4.83	5.06	3.65	2.81	2.28	1.23	2.18	2.38	1.49	1.50
	4.25	9.16	4.66	4.56	3.98	2.81	2.08	1.13	1.78	2.13	1.59	1.50
	4.08	9.16	4.66	4.48	4.98	2.56	1.98	1.18	1.78	1.88	1.59	1.50
	4.16	8.66	5.00	3.90	6.06	2.56	2.03	1.28	1.63	1.73	1.49	1.40
	4.66	9.16	5.58	3.31	6.56	2.65	1.88	1.18	1.43	1.88	1.54	1.40
	5.50	10.16	6.66	3.73	5.31	2.56	1.93	1.28	1.33	2.93	1.59	1.50
	[c]15.50	10.16	7.08	3.56	4.56	2.56	2.98	1.28	1.18	3.76	1.69	1.60
	11.50	10.75	10.41	3.40	4.23	2.73	2.13	1.28	1.18	4.06	1.69	1.60
	10.16	10.41	11.00	3.48	3.81	2.48	1.83	1.68	1.08	3.58	1.79	1.60
	7.66	10.58	15.25	3.48	3.98	2.31	1.73	2.33	1.03	3.03	1.89	1.80
	6.83	9.50	13.83	3.73	3.90	2.06	1.68	2.08	1.13	2.68	1.84	1.90
	5.83	9.08	12.50	4.90	3.65	1.98	1.78	1.83	1.63	2.53	1.74	2.10
	4.75	.....	10.16	6.98	3.31	1.81	1.68	1.63	1.73	2.48	1.84	9.40
	4.50	.....	8.41	.....	3.40	.....	1.63	1.53	.....	2.28	.....	8.40

[a] From January 1 to July 17, inclusive, gage readings were taken at the pump house. From July to the end of the year the readings were taken at the Walnut Street Bridge. Beginning with ril 1 the readings at the pump house were too high by 0.6 foot, owing to the fact that a cofferdam s built just below the intake. This correction has been applied; therefore the gage readings for e complete year are referred to the low-water datum of 1903.

[b] River frozen over at 5 a. m.

[c] Several ice gorges existed both above and below Harrisburg from January 24 to March 13. These used the backing up of the water, thus increasing the gage height.

Rating table for Susquehanna River at Harrisburg, Pa., from 1891 to 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.05	2,330	2.4	16,950	5.8	65,000	12.0	174,500
+0.0	2,440	2.5	17,960	6.0	68,400	12.5	183,600
.1	2,710	2.6	19,010	6.2	71,900	13.0	193,000
.2	3,000	2.7	20,100	6.4	75,500	13.5	202,500
.3	3,330	2.8	21,210	6.6	79,200	14.0	212,000
.4	3,680	2.9	22,340	6.8	82,900	14.5	221,300
.5	4,070	3.0	23,480	7.0	86,500	15.0	231,000
.6	4,500	3.1	24,620	7.2	90,000	15.5	242,300
.7	4,980	3.2	25,760	7.4	93,400	16.0	254,500
.8	5,500	3.3	26,910	7.6	96,700	16.5	267,400
.9	6,020	3.4	28,130	7.8	100,100	17.0	280,400
1.0	6,550	3.5	29,430	8.0	103,500	17.5	293,600
1.1	7,090	3.6	30,800	8.2	106,900	18.0	306,700
1.2	7,650	3.7	32,200	8.4	110,300	19.0	334,500
1.3	8,240	3.8	33,600	8.6	113,800	20.0	363,100
1.4	8,850	3.9	35,000	8.8	117,300	21.0	392,600
1.5	9,520	4.0	36,400	9.0	120,800	22.0	423,100
1.6	10,200	4.2	39,200	9.2	124,300	23.0	454,600
1.7	10,930	4.4	42,200	9.4	127,800	24.0	487,000
1.8	11,700	4.6	45,400	9.6	131,400	25.0	520,200
1.9	12,500	4.8	48,600	9.8	134,900	26.0	554,400
2.0	13,300	5.0	51,900	10.0	138,400	27.0	589,400
2.1	14,160	5.2	55,100	10.5	147,200		
2.2	15,050	5.4	58,400	11.0	156,300		
2.3	15,980	5.6	61,700	11.5	165,300		

Mean daily discharge, in second-feet, of Susquehanna River at Harrisburg, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	(a)	75,500	97,600	31,500	12,500	10,060	9,048	11,540	13,980	11,620
2	(a)	(a)	(a)	141,000	80,100	35,000	11,160	10,780	8,120	10,780	13,140	9,792
3	(a)	(a)	(a)	194,200	75,500	39,600	13,140	12,740	7,824	9,724	12,340	9,114
4	(a)	(a)	(a)	159,000	62,500	39,600	12,500	12,740	7,824	11,540	11,540	7,882
5	(a)	(a)	(a)	127,800	50,200	36,120	10,560	12,340	7,538	12,740	10,780	8,180
6	(a)	(a)	(a)	98,900	37,200	50,200	11,160	11,540	7,258	11,160	10,490	6,228
7	(a)	(a)	(a)	81,600	36,120	55,600	11,160	13,980	6,982	10,060	10,200	8,180
8	(a)	(a)	(a)	71,000	33,740	47,500	15,330	13,550	6,442	9,384	9,792	7,036
9	(a)	(a)	(a)	69,400	29,170	36,120	18,590	11,540	6,442	8,726	9,792	7,882
10	(a)	(a)	(a)	75,500	28,130	30,250	18,590	10,780	7,538	7,824	9,452	7,594
11	(a)	(a)	(a)	111,600	25,190	40,800	43,480	12,340	7,538	7,538	10,130	5,706
12	(a)	(a)	(a)	123,400	23,250	58,400	52,900	10,420	7,538	7,824	9,792	6,228

[a] The ice gorge during January, February, and March make it impossible to estimate daily flow.

Mean daily discharge, in second-feet, of Susquehanna River at Harrisburg, Pa., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
13	(a)	(a)	(a)	103,200	22,340	46,200	42,200	10,060	7,258	7,824	10,130	10,860
14	(a)	(a)	(a)	89,200	18,590	35,000	32,620	9,384	6,982	7,824	10,860	9,114
15	(a)	(a)	(a)	73,900	21,320	26,100	26,100	8,420	8,726	8,726	10,490	9,452
16	(a)	(a)	(a)	55,900	25,190	22,340	22,340	8,420	10,060	22,680	10,130	8,788
17	(a)	(a)	(a)	54,300	28,130	19,550	18,590	8,120	13,140	20,440	9,792	8,240
18	(a)	(a)	(a)	52,900	31,500	21,320	15,790	7,824	14,870	16,750	9,452	9,520
19	(a)	(a)	(a)	44,800	36,120	21,320	13,980	7,258	11,540	14,420	10,130	9,520
20	(a)	(a)	(a)	43,500	51,540	18,590	13,140	7,538	11,540	12,340	10,130	9,520
21	(a)	(a)	(a)	35,000	69,400	18,590	13,550	8,120	10,420	11,160	9,452	8,850
22	(a)	(a)	(a)	27,030	78,400	19,550	12,340	7,538	9,048	12,340	9,792	8,850
23	(a)	(a)	(a)	32,620	56,900	18,590	12,740	8,120	8,420	22,680	10,130	9,520
24	(a)	(a)	(a)	30,250	44,800	18,590	23,250	8,120	7,538	33,040	10,860	10,200
25	(a)	(a)	(a)	23,130	39,600	20,440	14,420	8,120	7,538	37,240	10,860	10,200
26	(a)	(a)	(a)	29,170	33,740	17,760	11,940	10,780	6,982	30,520	11,620	10,200
27	(a)	(a)	(a)	29,170	36,120	16,080	11,160	16,270	6,712	23,820	12,420	11,700
28	(a)	(a)	(a)	32,620	35,000	13,820	10,780	13,980	7,258	19,880	12,020	12,500
29	(a)	(a)	(a)	50,200	31,500	13,140	11,540	11,940	10,420	18,270	11,230	14,160
30	(a)	(a)	(a)	86,100	27,030	11,780	10,780	10,420	11,160	17,760	12,020	b51,120
31	(a)	(a)	(a)	.....	28,130	.....	10,420	9,724	.....	15,790	.....	b44,120

[a] The ice gorge during January, February, and March make it impossible to estimate daily flow.
[b] Discharge for December 30 and 31 reduced to 40 per cent on account of ice gorge.

Estimated monthly discharge of Susquehanna River at Harrisburg, Pa., for 1904.

[Drainage area, 24,030 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	.....	.....	30,410	1.27	1.47
February [a]	.....	.....	38,590	1.61	1.74
March [a]	.....	.....	102,000	4.24	4.89
April	194,200	27,030	74,230	3.09	3.45
May	97,600	18,590	41,740	1.74	2.01
June	58,400	11,780	29,320	1.22	1.36
July	52,900	10,420	18,020	.750	.865
August	16,270	7,258	10,420	.434	.500
September	14,870	6,442	8,657	.360	.402
October	37,240	7,538	15,240	.634	.731
November	13,980	9,452	10,760	.448	.500
December	51,120	5,708	8,448	.352	.405
The year			32,320	1.350	18.320

[a] Owing to an ice gorge below Harrisburg the monthly mean for January, February, and March has been estimated by taking 89 per cent of means for McCall Ferry. Practically open conditions exist at the latter station.

SUSQUEHANNA RIVER AT M'CALL FERRY, PA.

This station is located at a narrow and rocky part of the Susquehanna River about 20 miles above its mouth and 1 mile above the village of McCall Ferry. It was established on May 17, 1902, by Boyd Ehle while investigating a power development there. For a considerable distance along this portion of the river the bank on the York County shore is the retaining wall of an abandoned canal which can be overtopped only in the greatest floods. The Lancaster shore, on the opposite side, is made up of almost equally vertical rock, and the railroad which skirts it has never yet been flooded at this point.

The gaging section first selected for this station is located at Duncan Run, where two islands, Hartman and Streepers, divide the river into three channels, ranging in width from 100 to 500 feet. At ordinary low water, however, two of these are dry, thus confining the discharge to the main or westernmost channel. The river bed at this section is of mica schistose rock, with some projecting bowlders and large irregularities. The flow, however, is comparatively free from the boils so common in a river of this character.

The discharge measurements at this section are made from a boat held in place by a rope stretched between the towpath and Streepers Island, the gaging points, 10 feet apart, being indicated by a tagged wire, which is also used in keeping the boat parallel to the current of the stream.

In order to provide for measuring the large floods which occur in the winter and spring months, a cable station was established by Mr. Ehle in the fall of 1902 about 1,000 feet downstream from the Duncan Run section. The banks of the river and the conditions of the river bed are very similar to those at the upper section, the only difference being that the bed is somewhat more irregular. During the low-water period of the fall of 1902 a careful survey was made of the section at the cable station and a contour map with 1-foot intervals was prepared from which the effective areas could be accurately determined, thus eliminating the error in discharge due to possible inaccuracies in the soundings at the time of the measurements. The width of the stream at this point is about 1,300 feet and the maximum depth during a gaging was 46 feet.

The car cable, a three-quarters inch 37-wire strand with a span of 1,450 feet, is anchored to 3-inch eyebolts set in cement in the solid rock on either side of the river. A 2-inch turn-buckle is provided at the York County end to regulate its height above the water. A high cliff on one shore and a large red oak on the other give the cable a 10-foot clearance over the highest floods on record. The car that runs on the cable accommodates two people and is propelled by a sheave provided with a crank. Eighty feet upstream from the main cable is

aspended a five-eighths inch secondary cable, along which runs a ·olley carrying a guy rope to hold the meter against the current. Measuring points for this section are 50 feet apart, and are indicated y red and white bands painted on the main cable, the intermediate istances being readily estimated by counting the revolutions of the ıeaves.

The measurements at both of the above stations are referred to two ermanent gages, designated Nos. 2 and 5. These are painted on the ock, and give elevations directly above sea level. Gage No. 2 is ocated at a point about three-fourths of a mile below the village of McCall Ferry, in the tailrace of the proposed power house, and has een read daily since June, 1902. The records in the following tables ıave been referred to this gage. Gage No. 5 is placed about 2 miles elow McCall Ferry, at the foot of Cullys Falls, so located in order to e entirely out of the influence of the proposed dam. One of the purposes of such extensive preparations as have been made at this point s to obtain data for determining the coefficient of discharge over ogee-faced weirs under high heads, and it is for use in these investigations that gage No. 5 was established.

The methods used in carrying on the work at the McCall Ferry station are practically the same as those employed by the hydrographers of the United States Geological Survey. Every effort has been made to eliminate any source of error, and vertical velocity-curve determinations were made wherever possible. At Duncan Run, in order to make these measurements, an 80-pound weight, with pulley and rope attached, was dropped to the bottom, so that the meter could be pulled down without being washed too far from the section. When the surface velocity, or 0.6 method, was used, the results were reduced by coefficients determined from these vertical velocity-curves. At the cable station the secondary cable, with the aid of the guy rope, made it possible to get vertical velocity-curve measurements at much greater velocities and depths. A No. 12 telegraph wire was found to be more satisfactory at such times for holding the meter than the insulated cable ordinarily used, as it offered less resistance to the current, would allow the meter to sink deeper, and, being less bowed by the water, would show more accurately its depth below the surface. In this way vertical velocity-curves were obtained to depths of 20 feet and in currents of 10 feet per second.

During the highest stages, when the velocity sometimes reaches 17 feet per second, readings could be taken only at the surface. These results were, however, reduced by coefficients determined from the vertical velocity-curve for each measuring point.

All records and estimates for this station for years prior to 1905 have been published in Water-Supply Paper No. 109.

Discharge measurements of Susquehanna River at McCall Ferry, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.[a]	Discharge.
		Sq. ft.	*Ft. per sec.*	*Feet.*	*Second-ft.*
March 8[a]	R. H. Anderson	54,500	[c]11.6	146.6	631,000
May 11[a]	do	7,035	[c]4.7	119.00	34,400
September 29[b]	W. G. Steward	3,717	2.16	114.75	7,940

[a] At cable section. [b] At Duncan Run section. [c] Reduced surface velocities.

Mean daily gage height, in feet, of Susquehanna River at McCall Ferry, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	116.6	120.0	120.0	123.9	125.2	119.4	116.8	115.8	115.5	116.2	117.1	116.0
2	116.3	119.0	121.0	129.2	124.4	119.3	116.5	115.7	115.3	116.1	116.9	115.9
3	115.9	118.5	122.0	132.6	123.3	119.9	116.3	116.0	115.1	116.0	116.8	115.8
4	[a]115.8	117.9	122.9	130.0	122.5	120.4	116.0	116.6	115.5	115.8	116.5	115.5
5	116.0	117.3	128.0	127.0	121.5	120.2	116.0	116.6	115.3	115.9	116.3	115.3
6	116.5	117.0	128.0	125.0	120.9	120.8	116.0	116.4	115.1	115.5	116.2	115.3
7	116.9	118.5	126.4	123.9	120.0	122.3	116.2	116.6	115.0	115.8	115.9	115.1
8	115.8	119.4	[b]146.6	123.1	119.8	121.4	116.5	116.7	114.9	115.7	115.7	115.0
9	115.5	121.5	130.2	123.2	119.5	120.1	117.0	116.7	114.8	115.5	115.5	114.8
10	115.5	125.0	130.4	123.4	119.3	119.9	117.5	117.0	114.7	115.4	115.7	114.7
11	116.0	125.7	130.9	124.6	119.0	119.6	119.9	117.5	114.7	115.3	115.5	114.5
12	116.8	124.3	126.6	127.3	118.6	121.7	121.0	117.0	114.8	115.4	115.5	114.4
13	117.1	122.7	124.9	125.9	118.3	121.0	121.1	116.4	115.0	115.4	115.6	114.2
14	117.3	121.9	123.6	124.4	118.3	119.9	119.9	116.0	115.3	115.4	115.9	114.2
15	117.3	121.0	122.3	123.6	118.2	119.3	119.0	115.7	115.8	115.3	116.0	114.4
16	117.4	120.4	121.5	122.6	119.0	118.5	118.5	115.5	116.1	115.4	116.0	115.3
17	117.0	119.5	121.1	121.9	119.5	118.3	118.7	115.3	116.4	118.2	115.9	114.6
18	116.6	118.6	120.7	121.6	119.7	118.0	117.4	115.2	117.0	118.0	115.8	114.6
19	116.4	118.0	120.9	121.0	120.3	118.0	117.0	115.2	116.8	117.5	115.7	114.6
20	116.0	117.8	121.0	120.6	121.3	117.9	116.8	115.3	116.5	116.8	115.7	114.5
21	116.0	118.0	121.6	120.2	122.7	117.8	116.6	115.7	116.3	117.0	115.7	114.6
22	117.4	120.0	122.6	120.1	123.8	117.2	116.5	115.6	116.0	117.3	115.6	114.5
23	122.3	120.9	123.0	119.9	122.8	118.0	116.4	115.5	115.8	117.5	115.5	114.5
24	[c]120.7	120.1	123.9	119.5	121.0	117.9	116.4	115.4	115.6	118.7	115.7	114.8
25	129.3	120.7	128.3	119.3	120.6	118.0	117.8	115.3	115.2	119.7	115.7	115.0
26	126.8	120.7	130.0	119.2	119.9	117.8	117.4	115.4	114.9	120.0	115.8	114.9
27	124.0	120.3	131.6	119.3	120.2	117.3	116.5	115.7	114.8	119.3	116.0	115.0
28	123.0	119.8	132.9	119.7	119.9	116.9	116.3	116.9	114.6	118.5	116.3	115.1
29	122.3	119.0	130.7	121.0	119.6	116.8	116.0	116.6	114.8	117.9	115.7	115.5
30	121.4	.....	128.9	122.1	119.0	116.7	116.0	116.1	115.8	117.8	116.1	116.2
31	120.5	.....	125.3	.....	119.6	.....	115.9	115.8	.....	117.5	.....	123.0

[a] Entire river covered with 14- to 18-inch ice.
[b] Ice moved at 2 p. m.
[c] Ice broke and went out of deeps at 5.30 p. m.; 133.8 maximum reading during night, 24th and 25th.

ating table for Susquehanna River at McCall Ferry, Pa., for 1902 to 1904.

	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
)	5,160	116.4	15,610	120.6	44,200	126.0	112,900
l	5,500	116.5	16,150	120.8	46,100	126.5	119,900
2	5,840	116.6	16,690	121.0	48,000	127.0	127,000
3	6,200	116.7	17,240	121.2	50,000	127.5	134,100
4	6,560	116.8	17,800	121.4	52,100	128.0	141,100
5	6,930	116.9	18,360	121.6	54,300	128.5	148,300
6	7,310	117.0	18,930	121.8	56,600	129.0	155,300
7	7,700	117.2	20,120	122.0	59,000	129.5	163,400
8	8,100	117.4	21,320	122.2	61,500	130.0	172,500
9	8,500	117.6	22,560	122.4	64,000	130.5	182,800
)	8,920	117.8	23,820	122.6	66,500	131.0	194,100
l	9,340	118.0	25,110	122.8	69,000	131.5	205,800
2	9,770	118.2	26,430	123.0	71,500	132.0	217,300
3	10,210	118.4	27,780	123.2	74,000	132.5	228,600
4	10,660	118.6	29,140	123.4	76,400	133.0	240,000
5	11,120	118.8	30,500	123.6	78,900	133.5	251,200
6	11,580	119.0	31,900	123.8	81,500	134.0	262,000
7	12,060	119.2	33,300	124.0	84,200	134.5	273,600
8	12,540	119.4	34,700	124.2	87,000	135.0	285,300
9	13,040	119.6	36,100	124.4	89,900	135.5	297,200
)	13,540	119.8	37,500	124.6	92,800	136.0	309,300
l	14,040	120.0	39,100	124.8	95,700		
2	14,560	120.2	40,700	125.0	98,600		
3	15,080	120.4	42,400	125.5	105,900		

daily discharge, in second-feet, of Susquehanna River at McCall Ferry, Pa., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
..	16,690	39,100	39,100	82,800	101,500	34,700	17,800	12,540	11,120	14,560	19,520	13,540
..	15,080	31,900	48,000	158,400	89,900	34,000	16,150	12,060	10,210	14,040	18,360	13,040
..	13,040	28,460	59,000	230,900	75,200	38,300	15,080	13,540	9,340	13,540	17,800	12,540
..	12,540	24,460	70,200	172,500	65,300	42,400	13,540	16,690	11,120	12,540	16,150	11,120
..	13,540	20,720	141,100	127,000	53,200	40,700	13,540	16,690	10,210	13,040	15,080	10,210
..	16,150	18,930	141,100	98,600	47,050	46,100	13,540	15,610	9,340	11,120	14,560	10,210
..	18,360	28,460	118,500	82,800	39,100	62,800	14,560	16,690	8,920	12,540	13,040	9,340
..	12,540	34,700	a300,000	72,700	37,500	52,100	16,150	17,240	8,500	12,060	12,060	8,920
..	11,120	53,200	176,500	74,000	35,400	39,900	18,930	17,240	8,100	11,120	11,120	8,100
..	11,120	98,600	180,700	76,400	34,000	38,300	21,940	18,930	7,700	10,660	12,060	7,700
..	13,540	108,700	192,000	92,800	31,900	36,100	38,300	21,940	7,700	10,210	11,120	6,930
..	17,800	88,500	121,300	131,300	29,140	55,400	48,000	18,930	8,100	10,660	11,120	6,560
..	19,520	67,700	97,100	111,500	27,100	48,000	49,000	15,610	8,920	10,660	11,580	5,840
..	20,720	57,800	78,900	89,900	27,100	38,300	38,300	13,540	10,210	10,660	13,040	5,840

a *Maximum discharge*, 631,000 mean daily discharge estimated.

Mean daily discharge, in second-feet, of Susquehanna River at McCall Ferry, Pa., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	20,720	48,000	62,800	78,900	26,430	34,000	31,900	12,060	12,540	10,210	13,540	6,560
16	21,320	42,400	53,200	66,500	31,900	28,460	28,460	11,120	14,040	10,660	13,540	10,210
17	18,930	35,400	49,000	57,800	35,400	27,100	29,820	10,210	15,610	26,430	13,040	7,310
18	16,690	29,140	45,100	54,300	36,800	25,110	21,320	9,770	18,930	25,100	12,540	7,310
19	15,610	25,110	47,050	48,000	41,550	25,110	18,930	9,770	17,800	21,940	12,060	7,310
20	13,540	23,820	48,000	44,200	51,100	24,460	17,800	10,210	16,150	17,800	12,060	6,930
21	13,540	25,110	54,300	40,700	67,700	23,820	16,690	12,060	15,080	18,930	12,060	7,310
22	21,320	39,100	66,500	39,900	81,500	20,120	16,150	11,580	13,540	20,720	11,580	6,930
23	62,800	47,050	71,500	38,300	69,000	25,110	15,610	11,120	12,540	21,940	11,120	6,930
24	45,100	39,900	82,800	35,400	48,000	24,460	15,610	10,660	11,580	29,820	12,060	8,100
25	160,000	45,100	145,500	34,000	44,200	25,110	23,820	10,210	9,770	36,800	12,060	8,920
26	124,100	45,100	172,500	33,300	38,300	23,820	21,320	10,660	8,500	39,100	12,540	8,500
27	84,200	41,550	208,100	34,000	40,700	20,720	16,150	12,060	8,100	34,000	13,540	8,920
28	71,500	37,500	237,700	36,800	38,300	18,360	15,080	18,360	7,310	28,460	15,080	9,340
29	62,800	31,900	187,200	48,000	36,100	17,800	13,540	16,690	8,100	24,460	12,060	11,120
30	52,100	.....	153,900	60,200	31,900	17,240	13,540	14,040	12,540	23,820	14,040	14,560
31	43,300	.....	103,000	.....	36,100	.....	13,040	12,540	.....	21,940	.....	71,500

Estimated monthly discharge of Susquehanna River at McCall Ferry, Pa., for 1904.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	160,000	11,120	34,170	1.28	1.48
February	108,700	18,930	43,360	1.62	1.75
March	300,000	39,100	114,600	4.28	4.93
April	230,900	33,300	78,400	2.93	3.27
May	101,500	26,430	46,720	1.75	2.02
June	62,800	17,240	34,580	1.29	1.44
July	49,000	13,040	21,410	.800	.922
August	21,940	9,770	13,880	.519	.598
September	18,930	7,310	11,050	.413	.461
October	39,100	10,210	18,700	.698	.805
November	19,520	11,120	13,320	.498	.556
December	71,500	5,840	10,890	.407	.469
The year	300,000	5,840	36,760	1.37	18.70

CHENANGO RIVER AT BINGHAMTON, N. Y.

This station was established July 31, 1901. A standard chain gage attached to the hand rail on the upstream side of the first span from e right bank of Court Street Bridge in Binghamton. The bench ark is a circular chisel draft on the upstream corner of the bridge at on the left abutment. Its elevation is 34.02 feet above gage tum. The bridge to which the gage is attached stands squarely ross the stream at a point where there is a good bed of gravel and all cobblestones and a smooth, uniform current. The channel is structed by three masonry piers supporting the four spans of the idge, 79 feet clear width each, the bridge having a total length of 7 feet between abutments. A small rift between the station and the nfluence of Chenango River with the Susquehanna, about 2,500 feet low, cuts off backwater at ordinary stages of the rivers. For periods ring freshets or at times when there is an abnormal rise on one or th streams, either record may be affected by backwater and a too eat discharge indicated. For freshets of considerable duration the ect of backwater on the stage of the two streams may become considerable.

In estimating run-off of Chenango River the area directly tributary storage reservoirs, from which diversion is made to supply Erie nal, has been deducted from the total natural drainage area. The ersion area of six reservoirs at the head of Chenango River, whose tflow is turned into Erie Canal through Oriskany Creek, is 30 square les. The diversion area of De Ruyter reservoir, at the head of oughnioga River, whose outflow is turned into Erie Canal through mestone Creek, is 18 square miles. These two areas have been sub acted from the natural drainage area of 1,580 square miles, giving effective area of 1,532 square miles. This estimate is approximate, no allowance for direct inflow to feeder channels from additional eas, nor for waste into the original stream, has been made. The oss area from which more or less run-off is diverted is about 105 uare miles. Gage readings on Chenango River, as well as those on squehanna River at Binghamton, are taken by E. F. Weeks. All cords and estimates for this station for years prior to 1905 have en revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under e direction of R. E. Horton, district hydrographer.

Discharge measurements of Chenango River at Binghamton, N. Y., in 1904.

Date.	Hydrographer.	Area.	Mean velocity.	Gage height.	Discharge.
		Sq. ft.	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 8	C. C. Covert	3,702	3.45	[a] 14.90	9,104
April 8	R. E. Horton	2,459	5.42	10.86	11,632
July 12	C. C. Covert	595	.87	5.42	516
September 10	do	417	1.15	5.55	539
November 22	H. R. Beebe	1,022	2.45	6.86	2,505

[a] Backwater, caused by ice jam.

Mean daily gage height, in feet, of Chenango River at Binghamton, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.42	7.32	7.60	11.30	8.72	7.14	5.59	6.10	5.70	7.69	6.22	6.15
2	6.55	7.20	7.40	12.90	8.19	6.79	5.73	7.08	5.72	6.85	6.20	5.95
3	[b] 6.42	7.18	7.88	[a] 11.70	7.79	6.56	5.63	7.35	5.70	6.41	6.12	5.80
4	6.45	7.20	10.38	10.50	7.42	6.42	5.61	6.88	5.72	6.21	6.07	5.75
5	6.68	7.05	11.92	9.45	7.19	6.64	5.51	6.32	5.65	6.11	6.04	5.65
6	[c] 6.82	6.75	11.08	10.08	6.99	6.59	5.49	6.72	5.65	6.01	6.17	5.72
7	6.68	8.12	[c] 10.95	10.30	6.82	6.34	5.51	6.65	5.60	6.01	6.23	5.80
8	6.60	13.92	14.78	10.88	6.67	6.25	5.58	6.28	5.52	5.96	6.16	5.75
9	6.58	15.30	16.90	11.01	6.55	6.88	5.48	6.10	5.50	5.88	6.11	5.62
10	6.48	14.28	15.65	12.97	6.44	7.98	5.40	6.02	5.50	5.80	6.11	5.56
11	6.38	12.05	13.70	12.42	6.34	6.93	5.30	5.98	5.40	6.05	6.06	5.58
12	6.30	10.60	11.40	10.84	6.26	6.48	5.50	5.92	5.31	7.60	6.06	5.62
13	6.25	9.50	10.30	9.91	6.18	6.25	5.55	5.85	5.31	8.95	6.01	5.70
14	6.20	8.70	9.52	9.29	6.14	6.15	5.35	5.75	5.34	7.85	6.02	5.55
15	6.15	8.20	8.75	8.74	6.26	6.08	5.40	5.72	6.09	7.03	5.95	5.65
16	6.15	[c] 9.38	8.20	8.49	7.36	6.53	5.60	5.65	5.91	6.40	6.08	5.65
17	6.12	10.18	7.65	8.39	7.36	6.11	5.65	5.70	5.67	6.42	6.10	5.65
18	[b] 6.15	10.05	7.42	8.39	6.84	5.94	6.68	5.62	5.54	6.26	5.95	5.65
19	6.30	9.52	7.22	8.40	6.64	5.84	6.55	5.55	5.40	6.16	5.92	5.60
20	6.45	8.98	7.48	8.23	7.30	5.84	6.08	5.78	5.36	6.12	5.90	5.60
21	6.30	8.62	7.88	7.98	7.10	5.84	5.88	6.82	5.46	5.79	6.08	5.60
22	6.30	8.35	7.78	7.98	6.70	5.82	5.82	6.50	5.68	10.79	6.80	5.60
23	[d] 10.36	8.62	11.30	8.00	6.47	5.72	5.65	8.25	5.66	9.76	6.68	5.65
24	11.18	9.35	[f] 15.15	7.93	6.73	5.60	6.10	7.55	5.56	8.15	6.50	5.92
25	11.60	9.38	15.90	8.13	6.47	5.54	6.02	6.65	6.70	7.38	6.38	6.50
26	10.20	8.70	19.82	8.43	6.40	5.54	5.92	6.32	6.42	7.41	6.32	6.25
27	9.35	8.25	19.90	8.13	6.50	5.47	6.20	6.20	6.29	7.23	6.18	6.72
28	8.65	7.95	16.15	10.13	6.50	5.46	6.22	[a] 6.05	6.15	6.92	5.98	12.75
29	8.10	7.88	12.08	10.19	6.40	5.46	6.65	5.90	5.95	6.68	5.80	13.28
30	7.88	.....	10.62	9.39	6.26	5.49	6.90	5.80	6.92	6.53	6.20	10.15
31	7.60	.....	10.58	.....	6.76	.....	6.32	5.72	.....	6.32	.....	5.25

[a] Interpolated.
[b] Anchor ice.
[c] River partly frozen over.
[d] Current very sluggish.
[e] Backwater.
[f] Ice went out.

ble for Chenango River at Binghamton, N. Y., for 1901 to 1904, inclusive.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
160	7.4	3,200	10.6	8,590	15.4	18,240
256	7.5	3,350	10.8	8,970	15.6	18,660
352	7.6	3,500	11.0	9,350	15.8	19,080
450	7.7	3,650	11.2	9,730	16.0	19,500
550	7.8	3,800	11.4	10,110	16.2	19,940
650	7.9	3,950	11.6	10,490	16.4	20,380
760	8.0	4,100	11.8	10,870	16.6	20,820
875	8.1	4,250	12.0	11,250	16.8	21,260
995	8.2	4,400	12.2	11,650	17.0	21,700
1,115	8.3	4,550	12.4	12,050	17.2	22,140
1,235	8.4	4,700	12.6	12,450	17.4	22,580
1,365	8.5	4,850	12.8	12,850	17.6	23,030
1,495	8.6	5,020	13.0	13,250	17.8	23,490
1,625	8.7	5,190	13.2	13,650	18.0	23,950
1,755	8.8	5,360	13.4	14,050	18.2	24,410
1,885	8.9	5,530	13.6	14,460	18.4	24,870
2,025	9.0	5,700	13.8	14,880	18.6	25,340
2,165	9.2	6,060	14.0	15,300	18.8	25,820
2,305	9.4	6,420	14.2	15,720	19.0	26,300
2,450	9.6	6,780	14.4	16,140	19.2	26,780
2,600	9.8	7,140	14.6	16,560	19.4	27,260
2,750	10.0	7,500	14.8	16,980	19.6	27,760
2,900	10.2	7,860	15.0	17,400	19.8	28,280
3,050	10.4	8,220	15.2	17,820		

: Tangent at 19.5 feet. Difference above this point 260 per tenth.

discharge, in second-feet, of Chenango River at Binghamton, N. Y., for 1904.

	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
..	1,781	3,050	3,500	9,920	5,190	2,825	749	1,365	875	3,650	1,521	1,430
..	1,955	2,900	3,200	13,050	4,400	2,291	911	2,750	899	2,375	1,495	1,175
..	1,781	2,900	3,950	10,680	3,800	1,969	793	3,125	875	1,768	1,391	995
..	1,820	2,900	5,750	8,400	3,200	1,781	771	2,420	899	1,508	1,326	935
..	2,137	2,675	9,000	6,510	2,900	2,081	661	1,651	815	1,378	1,287	818
..	2,333	2,235	8,500	7,680	2,585	2,011	640	2,193	815	1,248	1,456	899
..	2,137	4,250	8,300	8,040	2,333	1,677	661	2,095	760	1,248	1,534	995
..	2,025	15,090	8,985	9,160	2,123	1,560	738	1,599	672	1,187	1,413	935
..	1,997	18,030	11,400	9,350	1,955	2,420	630	1,365	650	1,091	1,378	783
..	1,859	15,930	10,700	13,150	1,807	4,100	550	1,261	650	995	1,378	705
..	1,729	11,350	8,950	12,050	1,677	2,495	450	1,211	550	1,300	1,313	738
..	1,625	8,590	6,670	9,065	1,573	1,859	650	1,139	460	3,500	1,313	783
..	1,560	6,600	5,700	7,320	1,469	1,560	705	1,055	460	5,615	1,248	875

Mean daily discharge, in second-feet, of Chenango River at Binghamton, N. Y., for 19
Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
14	1,495	5,190	4,950	6,240	1,417	1,430	500	935	490	3,875	1,261
15	1,430	4,400	4,170	5,275	1,573	1,339	550	899	1,352	2,675	1,175
16	1,430	6,420	3,600	4,850	3,125	1,927	760	815	1,127	1,755	1,339
17	1,391	7,860	3,020	4,700	3,125	1,378	815	875	839	1,781	1,365
18	1,430	7,590	2,800	4,700	2,361	1,163	2,137	782	694	1,573	1,175
19	1,625	6,600	2,680	4,700	2,081	1,043	1,955	705	550	1,443	1,139
20	1,820	5,700	3,015	4,475	3,050	1,043	1,339	971	510	1,391	1,115
21	1,625	5,020	3,555	4,100	2,750	1,043	1,091	2,333	610	983	1,339
22	1,625	4,625	3,350	4,100	2,165	1,019	1,019	1,885	851	8,970	2,336
23	8,130	5,020	9,920	4,100	1,846	899	815	4,475	827	7,050	2,137
24	9,730	6,330	17,715	4,025	2,207	760	1,365	3,425	716	4,325	1,885
25	10,490	6,420	19,290	4,325	1,846	694	1,261	2,095	2,165	3,200	1,729
26	7,860	5,190	28,280	4,775	1,755	694	1,139	1,651	1,781	3,200	1,651
27	6,330	4,475	28,540	4,325	1,885	620	1,495	1,495	1,612	2,975	1,469
28	5,105	4,025	19,830	7,770	1,885	610	1,521	1,300	1,430	2,480	1,211
29	4,250	3,950	11,450	7,860	1,755	610	2,095	1,115	1,175	2,137	995
30	3,950	.....	8,590	6,420	1,573	640	2,450	995	2,480	1,927	1,495
31	3,500	.....	8,590	.....	2,249	.....	1,651	899	.....	1,651	.....

The daily discharge during January, February, and March are only approxim owing to the ice conditions. From March 4 to 22, 1904, the discharge was estim from the measurement of March 8, which was approximately 50 per cent of nor conditions. This was due to an ice gorge.

Estimated monthly discharge of Chenango River at Binghamton, N. Y., for 1904.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dept inc
January	10,490	1,391	3,160	2.06	2
February	18,030	2,235	6,390	4.17	4
March	28,540	2,680	8,966	5.84	6
April	13,150	4,025	7,037	4.59	5
May	5,190	1,417	2,376	1.55	1
June	4,100	610	1,518	.990	1
July	2,450	450	1,060	.691	
August	4,475	705	1,641	1.07	1
September	2,480	460	953	.621	
October	8,970	983	2,587	1.69	1
November	2,305	995	1,429	.932	1
December	13,810	401	1,981	1.29	1
The year	28,540	401	3,258	2.12	28

CHEMUNG RIVER AT CHEMUNG, N. Y.

Chemung River is formed at Painted Post, N. Y., by the confluence of Tioga and Cohocton rivers. Cohocton River lies entirely in the State of New York. Tioga River receives, just above its mouth, Canisteo River, a large tributary, which also has its drainage basin in New York to the south of the Cohocton. The drainage of Tioga River above the Canisteo is mainly in Pennsylvania. Chemung River flows southeasterly through Corning, Elmira, and Chemung, crosses the State line and flows for a short distance in Pennsylvania, then returns to New York and again crosses to Pennsylvania near Waverly, finally emptying into Susquehanna River near Athens, Bedford County, Pa. The total length of the river is about 40 miles, of which 30 miles lie in New York. It is a sluggish stream, with low banks and a broad valley or flood plain, which is often overflowed. It was formerly paralleled by a canal, which has now been abandoned. The principal water-power development on the river is at Elmira, N. Y.

The topographic features of the drainage basin are, as a rule, bold and broad. The hills rise to a height of several hundred feet on either side, and within a short distance of the stream; the upland plateau is to a large extent wooded, has impervious soil, no lake storage, and few marsh areas. Tributaries are ramifying and uniformly distributed, though not very numerous, and dry gullies or flood channels are common. The concentration of storm waters from the three large streams which unite just above Corning makes possible excessive floods. Dikes have been erected in the cities of Elmira and Corning for protection. One of the highest recorded freshets in the stream occurred June 1, 1889. It was preceded by phenomenal rainfall, aggregating several inches in a few hours during the night of May 31. The discharge at this time has been estimated by F. Collingwood at 67 second-feet per square mile from 2,055 square miles, or 138,000 second-feet.

The gaging station was established September 7, 1903, by R. E. Horton. It is located at the suspension highway bridge, midway between Chemung, N. Y., and Willawana, Pa., near the State line. The bridge has a single span of 395 feet. A standard chain gage is attached to the upstream side of the bridge near the right bank, and is read twice each day by Daniel L. Orcutt. Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the face of the right abutment on the downstream side. The channel is straight for 700 feet above and 800 feet below the station; the current is good. The right bank is high, cleared, and is not subject to overflow. The left bank is of medium height, wooded, and will overflow at high water. The bed of the stream is composed of gravel, and is clean and permanent. There is but one channel at

all stages. The bench mark is formed by three nails driven into a telephone pole 70 feet to the right of the initial point for soundings and about 30 feet upstream; elevation 29.88 feet above gage datum. The pole is marked with black paint, "U. S. G. S. B. M."

All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Chemung River at Chemung, N. Y.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 27	C. C. Covert	2.89	809
September 7	R. E. Horton	3.29	1,354
October 2	H. H. Halsey	2.47	611
October 12	C. C. Covert	6.72	8,766
1904.			
March 11	C. C. Covert	5.75	6,170
April 9	R. E. Horton	5.64	5,717
July 15	C. C. Covert	3.05	1,042
September 9	do	1.90	220

Mean daily gage height, in feet, of Chemung River at Chemung, N. Y.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1										2.24	2.98	2.90
2										2.40	2.88	2.88
3										2.52	3.88	2.88
4										2.57	2.83	2.88
5										2.74	2.86	2.82
6										3.30	2.90	2.59
7									3.29	3.37	3.08	3.69
8									2.24	4.62	2.98	2.79
9									3.19	9.97	4.93	2.69
10									3.16	7.78	2.90	2.64
11									4.84	8.80	2.88	2.49
12									4.56	6.74	2.86	2.49
13									3.84	6.12	2.80	2.69
14									3.46	4.97	2.73	2.69
15									3.22	4.47	2.68	2.69
16									3.06	4.20	2.76	2.74
17									2.96	3.92	7.06	2.74
18									3.44	7.04	8.13	2.64
19									3.46	6.24	5.88	2.64
20									3.29	4.90	4.88	2.64
21									2.99	4.42	4.26	2.69
22									2.84	4.12	3.98	2.74
23									2.54	3.87	3.88	2.79

daily gage height, in feet, of Chemung River at Chemung, N. Y.—Continued.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
									2.34	4.72	3.83	2.79
									2.34	3.54	3.78	2.79
									2.29	3.44	3.38	2.74
									2.24	3.32	3.23	2.69
									2.24	3.30	3.10	2.54
									2.22	3.24	3.10	2.44
									2.26	3.22	3.10	2.54
										3.13		2.64
	3.00	[a] 3.85	3.57	6.50	7.20	7.05	2.60	2.50	2.00	2.35	2.40	2.05
	2.95	3.50	3.37	9.00	6.25	5.85	2.88	2.42	2.02	2.42	2.30	2.00
	2.90	3.45	3.67	7.05	5.45	5.35	2.70	2.98	2.00	2.22	2.22	1.90
	2.90	3.35	8.57	5.75	5.02	4.85	2.62	2.82	1.95	2.10	2.20	1.90
	2.90	4.00	5.72	5.38	4.62	7.70	2.60	2.70	2.00	2.15	2.25	1.90
	2.90	4.20	4.72	5.15	4.40	5.95	2.58	2.60	1.98	2.18	2.20	1.90
	2.85	5.90	7.69	5.20	4.18	5.10	2.95	2.45	1.92	1.88	2.20	1.85
	2.90	[a] 16.70	[b] 15.97	5.25	4.00	4.62	2.85	2.35	1.95	1.95	2.22	1.65
	3.00	8.70	9.68	5.75	3.80	5.35	2.72	2.20	1.90	1.90	2.12	2.25
	3.00	6.85	6.48	9.55	3.70	6.15	2.75	2.15	1.90	1.95	2.18	2.10
	3.00	5.85	5.02	7.40	3.58	4.90	3.90	2.20	1.95	1.95	2.20	2.10
	3.00	5.40	4.90	6.55	3.40	4.42	3.68	2.18	1.95	2.10	2.20	2.10
	3.00	4.75	4.50	5.75	3.38	4.00	3.45	2.10	1.95	2.62	2.12	2.00
	3.00	4.22	4.30	5.15	3.30	3.70	3.45	2.08	1.90	3.65	2.08	2.00
	3.00	3.95	4.05	4.80	5.15	3.48	3.02	2.00	1.90	3.15	2.05	2.00
	[c] 3.15	3.65	3.88	4.80	6.75	4.05	2.82	2.00	1.90	2.82	2.25	2.00
	3.20	[d] 4.85	3.62	4.80	5.65	3.80	2.70	2.00	1.90	2.70	2.15	1.90
	3.20	4.55	3.78	5.10	5.00	3.42	2.62	1.95	1.90	2.60	2.20	1.90
	3.20	[e] 4.30	3.92	5.10	9.45	3.22	2.50	1.95	1.90	2.50	2.05	1.95
	3.20	4.15	5.98	4.85	8.40	3.12	2.40	2.05	1.88	2.45	2.00	2.00
	3.35	4.00	6.78	4.42	6.60	3.02	2.30	2.05	1.80	2.52	2.00	2.10
	3.50	[f] 4.12	5.20	4.55	5.40	3.10	2.35	2.30	1.75	3.40	2.00	2.05
	[g] 11.35	4.05	[h] 10.90	4.60	4.95	3.05	2.25	2.75	1.80	3.40	2.00	2.18
	[a] 9.55	4.32	11.40	4.50	5.35	3.05	2.72	2.88	1.82	3.18	2.02	2.10
	6.65	4.12	10.25	4.55	5.25	2.88	2.78	2.70	2.00	3.05	2.20	2.10
	5.30	4.05	[h] 13.20	4.82	4.75	2.80	2.55	2.45	2.15	2.85	2.15	2.15
	4.90	3.90	11.05	4.65	4.82	2.70	2.60	2.30	2.38	2.75	2.00	2.60
	4.20	3.37	7.28	9.10	5.40	2.65	2.50	2.12	2.35	2.65	1.95	6.40
	4.22	3.57	5.95	8.50	4.25	2.60	2.70	2.10	2.35	2.60	2.10	5.15
	4.25		5.60	7.42	4.00	2.60	2.80	2.08	2.35	2.45	1.95	3.90
	4.05		5.70		5.85		2.62	2.00		2.30		3.80

[a] No ice.
[b] Water over flats highest point 17 feet.
[c] River freezing over below gage.
[d] River frozen over.
[e] Thickness of ice 5 inches.
[f] Thickness of ice 12 inches.
[g] Ice running.
[h] River over the flats.

Rating table for Chemung River at Chemung N. Y., from August 27, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.75	146	4.00	2,255	6.30	7,575	8.60	14,260
1.80	170	4.10	2,420	6.40	7,855	8.70	14,560
1.90	220	4.20	2,590	6.50	8,135	8.80	14,860
2.00	273	4.30	2,765	6.60	8,415	8.90	15,160
2.10	328	4.40	2,950	6.70	8,700	9.00	15,460
2.20	385	4.50	3,140	6.80	8,985	9.10	15,760
2.30	445	4.60	3,340	6.90	9,270	9.20	16,060
2.40	510	4.70	3,550	7.00	9,560	9.30	16,360
2.50	575	4.80	3,765	7.10	9,850	9.40	16,660
2.60	645	4.90	3,990	7.20	10,140	9.50	16,960
2.70	720	5.00	4,220	7.30	10,430	9.60	17,260
2.80	800	5.10	4,455	7.40	10,720	9.70	17,560
2.90	890	5.20	4,695	7.50	11,010	9.80	17,860
3.00	985	5.30	4,940	7.60	11,300	9.90	18,160
3.10	1,085	5.40	5,190	7.70	11,590	10.00	18,460
3.20	1,190	5.50	5,445	7.80	11,880	11.00	21,460
3.30	1,300	5.60	5,700	7.90	12,170	12.00	24,460
3.40	1,415	5.70	5,960	8.00	12,460	13.00	27,460
3.50	1,540	5.80	6,220	8.10	12,760	14.00	30,460
3.60	1,670	5.90	6,485	8.20	13,060	15.00	33,460
3.70	1,805	6.00	6,750	8.30	13,360	16.00	36,460
3.80	1,945	6.10	7,020	8.40	13,660		
3.90	2,095	6.20	7,295	8.50	13,960		

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 1.90 and 3.30 feet. The table has been extended above gage height 6.70 feet. Above gage height 8.00 feet the rating curve is a tangent, the difference being 300 per tenth. The rating table has been applied to the nearest hundredth of a foot to gage height 6.00, to the nearest half-tenth of a foot to gage height 9.00, to the nearest tenth of a foot above gage height 9.00 feet.

Mean daily discharge, in second-feet, of Chemung River at Chemung, N. Y.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1										409	966	890
2										510	872	872
3										589	2,065	872
4										624	827	872
5										752	854	818
6										1,300	890	638
7									1,289	1,380	1,065	1,791
8									409	3,382	966	792

y discharge, in second-feet, of Chemung River at Chemung, N. Y.—Continued.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	.....	.....	.....	.....	.....	.....	1,180	18,460	4,059	712
.....	.....	.....	.....	.....	.....	.....	.....	1,148	11,880	890	675
.....	.....	.....	.....	.....	.....	.....	.....	3,855	14,860	872	568
.....	.....	.....	.....	.....	.....	.....	.....	3,260	8,840	854	569
.....	.....	.....	.....	.....	.....	.....	.....	2,005	7,020	800	712
.....	.....	.....	.....	.....	.....	.....	.....	1,490	4,157	748	712
.....	.....	.....	.....	.....	.....	.....	.....	1,212	3,083	705	712
.....	.....	.....	.....	.....	.....	.....	.....	1,045	2,590	768	752
.....	.....	.....	.....	.....	.....	.....	.....	947	2,127	9,705	752
.....	.....	.....	.....	.....	.....	.....	.....	1,465	9,705	12,910	675
.....	.....	.....	.....	.....	.....	.....	.....	1,490	7,435	6,432	675
.....	.....	.....	.....	.....	.....	.....	.....	1,289	3,990	3,945	675
.....	.....	.....	.....	.....	.....	.....	.....	975	2,988	2,695	712
.....	.....	.....	.....	.....	.....	.....	.....	836	2,454	2,223	752
.....	.....	.....	.....	.....	.....	.....	.....	603	2,050	2,065	792
.....	.....	.....	.....	.....	.....	.....	.....	471	3,593	1,990	792
.....	.....	.....	.....	.....	.....	.....	.....	471	1,592	1,917	792
.....	.....	.....	.....	.....	.....	.....	.....	439	1,465	1,392	752
.....	.....	.....	.....	.....	.....	.....	.....	409	1,323	1,223	712
.....	.....	.....	.....	.....	.....	.....	.....	409	1,300	1,085	603
.....	.....	.....	.....	.....	.....	.....	.....	397	1,234	1,085	536
.....	.....	.....	.....	.....	.....	.....	.....	421	1,212	1,085	603
.....	.....	.....	.....	.....	.....	.....	.....	.....	1,116	.....	675
.....	.....	.....	8,135	10,140	9,705	645	575	273	478	510	300
.....	.....	.....	15,460	7,435	35,860	872	523	284	523	445	273
.....	.....	.....	9,705	5,318	5,065	720	966	273	397	397	220
.....	.....	.....	6,090	4,267	3,877	660	818	246	328	385	220
.....	.....	.....	5,140	3,382	11,590	645	720	273	356	415	220
.....	.....	.....	4,575	2,950	6,617	631	645	262	374	385	220
.....	.....	.....	4,695	2,556	4,455	938	542	231	210	385	195
.....	.....	36,460	4,817	2,255	3,382	845	477	246	246	397	100
.....	.....	17,560	6,090	1,945	5,065	736	385	220	220	339	415
.....	.....	8,135	17,260	1,805	7,158	760	356	220	246	374	328
.....	.....	4,267	10,720	1,644	3,990	2,095	385	246	246	385	328
.....	.....	3,990	8,275	1,415	2,988	1,778	374	246	328	385	328
.....	.....	3,140	6,090	1,392	2,255	1,477	328	246	660	339	273
.....	.....	2,765	4,575	1,300	1,805	1,477	317	220	1,732	317	273
.....	.....	2,337	3,765	4,575	1,515	1,005	273	220	1,138	300	273
.....	.....	2,065	3,765	8,842	2,337	818	273	220	818	415	273
.....	.....	1,697	3,765	5,830	1,945	720	273	220	720	356	220
.....	.....	1,917	4,455	4,220	1,440	660	246	220	645	385	220
.....	.....	2,127	4,455	16,660	1,212	575	246	220	575	300	246
.....	.....	6,697	3,877	13,660	1,106	510	300	210	542	273	273
.....	.....	8,985	2,988	8,415	1,005	445	300	170	589	273	328
.....	.....	4,695	3,240	5,190	1,085	477	445	146	1,415	273	300
.....	.....	21,160	3,340	4,105	1,035	415	760	170	1,415	273	374
.....	.....	22,660	3,140	5,065	1,035	736	872	180	1,169	284	328
.....	.....	19,060	3,240	4,817	872	784	720	273	1,035	385	328
.....	.....	28,060	3,810	3,658	800	610	542	356	845	356	356
.....	.....	21,460	3,445	3,810	720	645	445	497	760	373	645
.....	.....	10,430	15,760	5,190	683	575	339	477	682	246	7,855
.....	.....	6,617	13,960	2,678	645	720	328	477	645	328	4,575
.....	.....	5,700	10,720	2,255	645	800	317	477	542	246	2,095
.....	.....	5,960	.....	6,352	.....	660	273	.....	445	.....	1,945

Estimated monthly discharge of Chemung River near Chemung, N. Y., for 1903-4.

[Drainage area, 2,440 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth inch
1903.					
September 7–30	3,855	397	1,146	0.47	0.
October	18,460	409	3,981	1.63	1.
November	12,910	705	2,265	.93	1.
December	1,791	536	757	.31	
1904.					
March 8–31	36,460	1,697	10,331	4.23	3
April	17,260	2,988	6,645	2.72	3
May	16,660	1,300	4,940	2.02	2
June	35,860	645	4,063	1.67	1
July	2,095	415	820	3.36	
August	966	246	463	.190	
September	497	146	267	.109	
October	1,732	210	656	.269	
November	510	246	347	.142	
December	7,855	100	785	.322	
The year	36,460	100	2,932	1.20	1

SUSQUEHANNA RIVER (WEST BRANCH) AT WILLIAMSPORT, PA.

This station was established March 1, 1895, by George D. Sn who was at that time city engineer, and daily gage heights have recorded since that date. On August 16, 1901, a standard chain was installed on the upper side of Market Street Bridge by E. G. The length of the chain from the end of the weight to the mark 40.29 feet. The bench mark is a cut in the face of the left abut 10.07 feet above gage datum. Discharge measurements are made the lower side of the bridge. The initial point for soundings i face of the abutment on the left bank. The channel is straigh several hundred feet above and below the station, is broken by bridge piers, and is about 1,000 feet wide at the station. There dam about one-half mile above. Both banks are high and rocky. bed of the stream is composed of gravel and silt, and will prol change to some extent in the shore spans. The current veloc sufficient for accurate measurement except at extreme low st During nearly ten years, from March, 1895, to January, 190 range of gage height at this station has been 21.3 feet, and the mated maximum and minimum discharges have been 164,100 an cubic feet per second, respectively. The gage is read once each d

Henry H. Guise, who is employed in the city engineer's office. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Susquehanna River (West Branch) at Williamsport, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 19	R. J. Taylor	3,874	1.09	2.07	4,220
September 14	J. C. Hoyt	2,550	0.53	0.52	1,340
September 30	do	3,040	0.67	1.10	2,060

Mean daily gage height, in feet, of Susquehanna River (West Branch) at Williamsport, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.2	3.8	2.7	6.2	7.8	3.6	2.3	1.0	0.4	0.8	1.0	0.6
2	2.2	3.4	7.0	16.8	7.0	3.7	2.1	.9	.4	1.0	1.0	.5
3	2.0	3.0	7.5	13.6	6.2	3.7	1.9	.9	.4	1.0	1.0	.5
4	2.0	2.8	19.0	9.8	5.5	3.5	1.7	.9	.3	.9	1.0	.4
5	1.8	3.0	16.5	8.0	5.0	6.1	1.5	.8	.3	.8	.9	a .4
6	1.8	2.4	9.2	6.8	4.5	4.5	1.5	.7	.3	.8	.9	.4
7	1.7	2.6	7.4	6.4	4.2	3.7	1.7	.7	.2	.7	.8	.4
8	1.7	b 5.0	17.4	6.0	3.9	3.4	1.8	.7	.2	.7	.7	.4
9	1.7	c 10.5	13.5	6.0	3.6	3.2	3.4	.6	.2	.6	.6	.4
10	1.7	c 7.6	9.8	8.8	3.3	3.2	4.4	.5	.2	.6	.6	.4
11	1.7	c 6.0	7.6	9.2	3.2	3.3	8.1	.5	.2	.6	.7	.4
12	1.7	c 5.2	6.5	7.9	3.0	3.3	6.7	.4	.5	.5	.7	.4
13	1.7	c 4.3	5.8	7.2	2.8	2.9	5.4	.4	.6	.7	.7	.3
14	1.7	3.8	5.3	6.6	2.5	2.7	4.6	.5	.5	1.2	.8	.3
15	1.6	4.0	5.0	5.8	3.0	2.4	3.8	.5	.5	1.5	.8	.3
16	1.6	d 3.8	4.4	5.2	3.4	2.6	3.4	.5	.6	1.4	.7	.3
17	1.5	d 3.6	4.1	5.2	3.3	3.1	3.0	.3	.5	1.3	.7	.3
18	1.5	d 3.5	3.8	5.1	3.2	2.8	2.5	.3	.5	1.2	.7	.2
19	1.5	3.3	4.0	5.0	4.7	2.6	2.1	.3	.4	1.1	.7	.2
20	1.5	d 3.0	4.5	4.5	7.7	2.3	2.0	.4	.3	1.0	.7	.2
21	1.4	2.9	6.5	4.2	7.2	2.3	1.7	.5	.3	1.1	.6	.2
22	1.5	2.8	6.7	3.9	6.0	3.0	1.5	.5	.2	1.5	.6	.2
23	7.7	2.7	6.6	3.6	5.2	3.7	1.3	.9	.2	1.7	.6	.2
24	13.3	3.7	e 9.9	3.3	4.7	4.0	1.3	1.0	.2	1.6	.7	.3
25	9.8	4.2	10.3	3.2	4.4	3.2	1.2	1.2	.2	1.5	.6	.3
26	7.0	3.8	11.3	3.6	4.2	2.8	1.1	1.0	.3	1.5	.6	.3
27	5.4	3.0	f 12.6	4.3	4.0	2.3	1.1	.9	.6	1.4	.6	.4
28	4.9	2.7	10.6	5.1	3.8	2.1	1.1	.7	1.0	1.3	.6	1.8
29	3.	2.5	8.0	6.8	3.5	1.9	1.1	.6	1.0	1.3	.5	5.4
30	3.2	.....	6.9	8.4	3.3	1.7	1.0	.6	1.1	1.2	.5	5.5
31	3.6	.....	6.0	.....	3.3	.....	1.0	.5	.....	1.1	.....	4.4

a River frozen December 5 to 28, 1904.
b Ice running.
c Slush ice running.
d Anchor ice running.
e Noon river 18 feet.
f Extreme height.

Rating table for Susquehanna River (West Branch) at Williamsport, Pa., from 1895 to 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
—0.2	410	2.2	4,530	6.0	18,330	10.6	47,400
.0	600	2.3	4,770	6.2	19,330	10.8	49,000
.1	710	2.4	5,010	6.4	20,340	11.0	50,600
.2	830	2.5	5,250	6.6	21,360	11.2	52,200
.3	970	2.6	5,500	6.8	22,380	11.4	53,800
.4	1,120	2.7	5,760	7.0	23,400	11.6	55,500
.5	1,280	2.8	6,020	7.2	24,600	11.8	57,200
.6	1,440	2.9	6,300	7.4	25,700	12.0	58,900
.7	1,610	3.0	6,580	7.6	26,900	12.2	60,700
.8	1,780	3.2	7,170	7.8	28,100	12.4	62,500
.9	1,960	3.4	7,780	8.0	29,300	12.6	64,300
1.0	2,140	3.6	8,400	8.2	30,500	12.8	66,100
1.1	2,320	3.8	9,030	8.4	31,800	13.0	67,900
1.2	2,510	4.0	9,690	8.6	33,100	13.2	69,800
1.3	2,700	4.2	10,400	8.8	34,400	13.4	71,700
1.4	2,890	4.4	11,150	9.0	35,800	13.6	73,600
1.5	3,080	4.6	11,940	9.2	37,200	13.8	75,500
1.6	3,270	4.8	12,750	9.4	38,600	14.0	77,500
1.7	3,460	5.0	13,600	9.6	40,000	14.5	82,600
1.8	3,660	5.2	14,500	9.8	41,400	15.0	87,800
1.9	3,860	5.4	15,420	10.0	42,800		
2.0	4,070	5.6	16,370	10.2	44,300		
2.1	4,300	5.8	17,340	10.4	45,800		

Mean daily discharge, in second-feet, of Susquehanna River (West Branch) at Williamsport, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4,530	9,030	5,760	19,330	28,100	8,400	4,770	2,140	1,120	1,780	2,140	1,4[illegible]
2	4,530	7,780	23,400	107,800	23,400	8,710	4,300	1,960	1,120	2,140	2,140	1,2[illegible]
3	4,070	6,580	26,300	73,600	19,330	8,710	3,860	1,960	1,120	2,140	2,140	1,2[illegible]
4	4,070	6,020	135,100	41,400	15,890	8,090	3,460	1,960	970	1,960	2,140	1,1[illegible]
5	3,660	6,580	104,300	29,300	13,600	18,830	3,080	1,780	970	1,780	1,960	1,1[illegible]
6	3,660	5,010	37,200	22,380	11,540	11,540	3,080	1,610	970	1,780	1,960	1,1[illegible]
7	3,460	5,500	25,700	20,340	10,400	8,710	3,460	1,610	830	1,610	1,780	1,1[illegible]
8	3,460	13,600	115,000	18,330	9,360	7,780	3,660	1,610	830	1,610	1,610	1,1[illegible]
9	3,460	46,600	72,600	18,330	8,400	7,170	7,780	1,440	830	1,440	1,440	1,1[illegible]
10	3,460	26,900	41,400	34,400	7,470	7,170	11,150	1,280	830	1,440	1,440	1,1[illegible]
11	3,460	18,330	26,900	37,200	7,170	7,470	29,950	1,280	830	1,440	1,610	1,1[illegible]
12	3,460	14,500	20,850	28,700	6,580	7,470	21,870	1,120	1,280	1,280	1,610	1,1[illegible]
13	3,460	10,770	17,340	24,600	6,020	6,300	15,420	1,120	1,440	1,610	1,610	9[illegible]
14	3,460	9,030	[illegible]	21,360	5,250	5,760	11,940	1,280	1,280	2,510	1,780	9[illegible]

Mean daily discharge, in second-feet, of Susquehanna River (West Branch) at Williamsport, Pa., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
5	3,270	9,690	13,600	17,340	6,580	5,010	9,030	1,280	1,280	3,080	1,780	970
6	3,270	9,090	11,150	14,500	7,780	5,500	7,780	1,280	1,440	2,890	1,610	970
7	3,080	8,400	10,040	14,500	7,470	6,870	6,580	970	1,280	2,700	1,610	970
8	3,080	8,090	9,030	14,050	7,170	6,020	5,250	970	1,280	2,510	1,610	830
9	3,080	7,470	9,690	13,600	12,340	5,500	4,300	970	1,120	2,320	1,610	830
0	3,080	6,580	11,540	11,540	27,500	4,770	4,070	1,120	970	2,140	1,610	830
1	2,890	6,300	20,850	10,400	24,600	4,770	3,460	1,280	970	2,320	1,440	830
2	3,080	6,020	21,870	9,360	18,330	6,580	3,080	1,280	830	3,080	1,440	830
3	27,500	5,760	21,360	8,400	14,500	8,710	2,700	1,960	830	3,460	1,440	830
4	70,700	8,710	42,100	7,470	12,340	9,690	2,700	2,140	830	3,270	1,610	970
5	41,400	10,400	45,000	7,170	11,150	7,170	2,510	2,510	830	3,080	1,440	970
6	23,400	9,030	53,000	8,400	10,400	6,020	2,320	2,140	970	3,080	1,440	970
7	15,420	6,580	64,300	10,770	9,690	4,770	2,320	1,960	1,440	2,890	1,440	1,120
8	13,170	5,760	47,400	14,050	9,030	4,300	2,320	1,610	2,140	2,700	1,440	3,660
9	8,090	5,250	29,300	22,380	8,090	3,860	2,320	1,440	2,140	2,700	1,280	7,640
0	7,170	.....	22,890	31,800	7,470	3,460	2,140	1,440	2,320	2,510	1,280	8,010
1	8,400	.....	18,330	.....	7,470	.....	2,140	1,280	.....	2,320	.....	4,220

Estimated monthly discharge of Susquehanna River (West Branch) at Williamsport, Pa., for 1904.

[Drainage area, 5,640 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
anuary	70,700	2,890	9,477	1.68	1.94
ebruary	46,600	5,010	10,320	1.83	1.97
larch	135,100	5,760	36,070	6.40	7.38
pril	107,800	7,170	23,760	4.21	4.70
lay	28,100	5,250	12,080	2.14	2.47
une	18,830	3,460	7,170	1.27	1.42
uly	29,950	2,140	6,219	1.10	1.27
ugust	2,510	970	1,541	.273	.315
eptember	2,320	830	1,170	.207	.231
ctober	3,460	1,280	2,309	.409	.472
ovember	2,140	1,280	1,648	.292	.326
ecember	8,010	1,120	1,660	.294	.339
The year	135,100	830	9,450	1.68	22.83

JUNIATA RIVER AT NEWPORT, PA.

This station, which is about 15 miles above the mouth of the river, was established March 21, 1899, by E. G. Paul. The standard chain gage has until the autumn of 1904 been located on the covered wagon bridge, 800 feet east of the public square at Newport, Pa. In the latter part of 1904 this bridge was removed and a steel structure will be erected on the same site. A standard chain gage will be attached to the new bridge immediately after its completion. In the meantime a temporary vertical staff gage, which has the same datum as the bench mark, has been attached to the exposed end of a sewer which discharges near the bridge, and the daily record of stage of river has been kept continuously. Bench mark No. 1 is on the extreme east end of the stone doorsill, east front of Ewing's store building, near end of bridge. The elevation above gage datum is 28.83 feet. Bench mark No. 2 is on shelf in southeast corner of underpinning of store of J. M. Ewing, elevation 27.37 feet above gage datum. This is a bench mark of the Pennsylvania Railroad and according to their levels is 390.69 feet above sea level. Discharge measurements have been made from the lower side of the wagon bridge to which the gage was attached. The channel is straight for one-half mile above and below the station. Both banks are high and are not subject to overflow. There is a single channel broken by three bridge piers. The piers do not interfere with the flow of the stream and there is little eddying and boiling near them. The bed is of hard material and is probably permanent. There is a good measurable velocity at all stages.

During nearly five years the range in gage height has been 22.8 feet, and the estimated maximum and minimum discharge has been 292,500 and 230 cubic feet per second, respectively.

The gage is read once each day by A. R. Bortel. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Juniata River at Newport, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1904.		*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 16	N. C. Grover	1,520	2.73	4.28	4,152

Mean daily gage height, in feet, of Juniata River at Newport, Pa., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	4.2	4.0	7.5	6.7	6.7	4.9	3.7	3.3	3.0	2.9	2.9	2.5
.....	4.2	5.0	12.0	13.4	6.1	5.6	3.7	3.3	3.0	2.9	2.9	2.8
.....	4.5	5.0	7.2	9.4	5.7	6.0	3.7	3.7	3.0	2.9	2.9	2.9
.....	4.6	5.0	13.5	7.7	5.3	5.4	3.7	3.6	3.0	2.9	2.9	3.2
.....	4.6	8.0	8.9	6.7	5.0	5.9	3.7	3.6	3.0	2.9	2.9	2.9
.....	4.6	8.5	6.0	5.7	4.8	5.9	3.7	3.5	3.0	2.9	2.8	3.1
.....	4.6	11.5	5.5	5.7	4.7	5.4	4.4	3.9	2.9	2.9	2.8	3.2
.....	4.5	8.5	14.0	5.3	4.6	4.7	5.1	3.5	2.9	2.9	2.8	3.2
.....	4.5	6.5	10.0	5.3	4.5	4.6	5.8	3.3	3.0	2.9	2.8	3.2
.....	4.5	5.0	7.2	6.3	4.4	4.5	7.2	3.3	3.0	2.9	2.8	3.1
.....	4.4	4.6	6.0	6.3	4.3	5.1	8.7	3.2	3.0	2.9	2.9	3.1
.....	4.2	4.2	6.0	6.0	4.2	4.6	7.1	3.2	3.0	2.9	2.9	3.1
.....	4.1	4.0	5.2	5.7	4.2	4.4	5.5	3.1	3.0	2.9	2.9	3.1
.....	4.1	3.9	5.2	5.3	4.2	4.2	5.3	3.1	2.9	2.9	2.9	3.1
.....	4.1	4.1	5.0	5.0	4.2	4.0	4.7	3.1	2.9	2.9	2.9	3.1
.....	4.1	4.2	4.8	4.8	4.2	4.0	4.7	3.1	3.0	2.9	2.9	3.1
.....	4.0	4.4	4.5	4.8	4.2	4.4	4.1	3.0	3.0	2.9	2.9	3.1
.....	4.0	5.0	4.5	4.7	4.3	3.9	3.9	3.2	3.0	2.9	2.9	3.1
.....	4.0	4.6	4.8	4.4	4.5	3.9	3.8	3.1	3.0	2.9	2.9	3.1
.....	4.0	4.7	4.5	4.4	6.7	3.9	3.9	3.2	2.9	2.9	2.8	3.1
.....	4.0	4.7	5.8	4.3	5.9	3.7	3.7	3.2	2.9	3.3	2.8	3.1
.....	4.0	5.0	5.5	4.2	5.5	5.7	3.6	3.2	2.9	3.3	2.8	3.1
.....	5.4	5.0	5.8	4.2	4.9	5.5	3.5	3.2	2.9	3.2	2.8	3.1
.....	[a] 11.0	5.4	8.0	4.0	4.6	5.3	3.8	3.2	2.9	3.1	2.7	3.2
.....	7.0	7.2	7.5	4.0	4.5	4.4	3.8	3.1	2.9	3.1	2.7	3.2
.....	5.5	7.4	6.9	4.0	4.6	4.0	3.7	3.1	2.9	3.0	2.7	3.2
.....	4.5	5.9	6.2	4.2	4.7	3.5	3.7	3.0	2.9	2.9	2.7	3.5
.....	4.1	4.8	6.2	4.6	4.5	3.8	3.5	3.0	2.9	2.9	2.6	3.7
.....	3.8	4.5	5.6	6.5	4.4	3.7	3.4	3.1	2.9	2.9	2.6	3.8
.....	3.7	.....	5.2	7.5	4.2	3.7	3.3	3.1	2.9	2.9	2.5	3.8
.....	3.8	.....	5.0	.....	4.6	.....	3.3	3.0	.....	2.9	.....	3.8

[a] Ice moved out.

Rating table for Juniata River at Newport, Pa., from 1899 to 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.5	230	4.7	5,180	6.9	14,570	10.2	38,500
2.6	320	4.8	5,510	7.0	15,170	10.4	40,300
2.7	430	4.9	5,850	7.1	15,770	10.6	42,200
2.8	570	5.0	6,200	7.2	16,370	10.8	44,100
2.9	750	5.1	6,550	7.3	16,970	11.0	46,000
3.0	950	5.2	6,910	7.4	17,570	11.2	48,000
3.1	1,160	5.3	7,270	7.5	18,170	11.4	50,100
3.2	1,370	5.4	7,640	7.6	18,770	11.6	52,200
3.3	1,580	5.5	8,010	7.7	19,380	11.8	54,300
3.4	1,790	5.6	8,390	7.8	20,000	12.0	56,400
3.5	2,000	5.7	8,770	7.9	20,640	12.2	58,600
3.6	2,210	5.8	9,150	8.0	21,300	12.4	60,800
3.7	2,430	5.9	9,540	8.2	22,700	12.6	63,100
3.8	2,650	6.0	9,930	8.4	24,100	12.8	65,400
3.9	2,880	6.1	10,330	8.6	25,500	13.0	67,700
4.0	3,120	6.2	10,740	8.8	27,000	13.2	70,100
4.1	3,380	6.3	11,200	9.0	28,500	13.4	72,600
4.2	3,650	6.4	11,720	9.2	30,100	13.6	75,100
4.3	3,930	6.5	12,270	9.4	31,700	13.8	77,600
4.4	4,220	6.6	12,830	9.6	33,400		
4.5	4,530	6.7	13,400	9.8	35,100		
4.6	4,850	6.8	13,980	10.0	36,800		

Mean daily discharge, in second-feet, of Juniata River at Newport, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,650	3,120	18,170	13,400	13,400	5,850	2,430	1,580	950	750	750	2
2	3,650	6,200	56,400	72,600	10,330	8,390	2,430	1,580	950	750	750	5
3	4,530	6,200	16,370	31,700	8,770	9,930	2,430	2,430	950	750	750	7
4	4,850	6,200	73,850	19,380	7,270	7,640	2,430	2,210	950	750	750	1,3
5	4,850	21,300	27,700	13,400	6,200	9,540	2,430	2,210	950	750	750	7
6	4,850	24,800	9,930	8,770	5,510	9,540	2,430	2,000	950	750	570	1,1
7	4,850	51,100	8,010	8,770	5,180	7,640	4,220	2,880	750	750	570	1,
8	4,530	24,800	80,100	7,270	4,850	5,180	6,550	2,000	750	750	570	1,
9	4,530	12,270	36,800	7,270	4,530	4,850	9,150	1,580	950	750	570	1,
10	4,530	6,200	16,370	11,200	4,220	4,530	16,370	1,580	950	750	570	1,
11	4,220	4,850	9,930	11,200	3,930	6,550	26,200	1,370	950	750	750	1,
12	3,650	3,650	9,930	9,930	3,650	4,850	15,770	1,370	950	750	750	1,
13	3,380	3,120	6,910	8,770	3,650	4,220	8,010	1,160	950	750	750	1,
14	3,380	2,880	6,910	7,270	3,650	3,650	7,270	1,160	750	750	750	1,
15	3,380	3,380	6,200	6,200	3,650	3,120	5,180	1,160	750	750	750	1,
16	3,380	3,650	5,510	5,510	3,650	3,120	5,180	1,160	950	750	750	1
17	3,120	4,220	4,530	5,510	3,650	4,200	3,380	950	950	750	750	1

ily discharge, in second-feet, of Juniata River at Newport, Pa., for 1904—Cont'd.

	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	3,120	6,200	4,530	5,180	3,930	2,880	2,880	1,370	950	750	750	1,160
.....	3,120	4,850	5,510	4,220	4,530	2,880	2,650	1,160	950	750	750	1,160
.....	3,120	5,180	4,530	4,220	13,400	2,880	2,880	1,370	750	750	570	1,160
.....	3,120	5,180	9,150	3,930	9,540	2,430	2,430	1,370	750	1,580	570	1,160
.....	3,120	6,200	8,010	3,650	8,010	8,770	2,210	1,370	750	1,580	570	1,160
.....	7,640	6,200	9,150	3,650	5,850	8,010	2,000	1,370	750	1,370	570	1,160
.....	46,000	7,640	21,300	3,120	4,850	7,270	2,650	1,370	750	1,160	430	1,370
.....	15,170	16,370	18,170	3,120	4,530	4,220	2,650	1,160	750	1,160	430	1,370
.....	8,010	17,570	14,570	3,120	4,850	3,120	2,430	1,160	750	950	430	1,370
.....	4,530	9,540	10,740	3,650	5,180	2,000	2,430	950	750	750	430	2,000
.....	3,380	5,510	10,740	4,850	4,530	2,650	2,000	950	750	750	320	2,430
.....	2,650	4,530	8,390	12,270	4,220	2,430	1,790	1,160	750	750	320	2,650
.....	2,430	.....	6,910	18,170	3,650	2,430	1,580	1,160	750	750	230	2,650
.....	2,650	.....	6,200	.....	4,850	.....	1,580	950	.....	750	.....	2,650

Estimated monthly discharge of Juniata River at Newport, Pa., for 1904.

[Drainage area, 3,476 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
a.....	46,000	2,430	5,722	1.65	1.90
.....	51,100	2,880	9,756	2.81	3.03
.....	80,100	4,530	17,150	4.93	5.68
.....	72,600	3,120	10,710	3.08	3.44
.....	13,400	3,650	5,742	1.65	1.90
.....	9,930	2,000	5,160	1.48	1.65
.....	26,200	1,580	4,968	1.43	1.65
.....	2,880	950	1,460	.420	.484
er.....	950	750	850	.245	.273
.....	1,580	750	856	.246	.284
er.....	750	230	607	.175	.195
er.....	2,650	230	1,344	.386	.445
ne year.....	80,100	230	5,360	1.54	20.93

a Frozen January 1 to 23. Rating table assumed to apply correctly.

BROAD CREEK AT MILL GREEN, MD.

basin of this creek lies wholly in Harford County, Md. It is lly hilly and is composed of farming lands. It is tributary to hanna River at a point a few miles above the fall line. This was established on December 14, 1904, by F. H. Tillinghast, best reached from Cardiff, Md. A standard chain gage is d to a steel highway bridge in the village of Mill Green; the

length of chain from the end of the weight to the marker is 14.97 feet. Gage datum is referred to bench marks as follows: 1. Chiseled square on upstream end of right abutment; elevation, 10.60 feet. 2. Top of chord of bridge directly over pulley of gage; elevation, 16.31 feet. 3. Nail in large blazed tree about 100 feet upstream from bridge on left bank; elevation, 12.83 feet. All elevations are above the datum of the gage. The channel is straight for 200 feet above and 500 feet below the station. The bed is rough and the velocity of the current at the bridge is small at low stages of the stream. Low-water measurements may be made by wading at a point about 100 feet above the station. The gage is read twice daily by James F. Snodgrass.

The maintenance of this station during 1904 was under the direction of N. C. Grover, district hydrographer.

DEER CREEK NEAR CHURCHVILLE, MD.

This creek has its headwaters in York County, Pa., flows southeasterly through Baltimore and Harford counties, Md., and is tributary to Susquehanna River opposite Port Deposit. Its basin is hilly and generally in farming lands. Slopes are steep, and at several places small power plants are in use. This station was established December 14, 1904, by F. H. Tillinghast, and is best reached by driving from Belair. A standard chain gage is attached to the highway bridge on the Deer Creek road about 3 miles north from Churchville. The length of chain from the end of the weight to the marker is 15.20 feet. The datum of the gage is referenced by the following bench marks: 1. Chiseled square on the downstream end of the right abutment; elevation, 14.10 feet. 2. Top of eyebar of bottom chord in middle of second panel from the right bank; elevation, 14.68 feet. The channel is straight for 500 feet above and below the station. The bed is generally smooth, is composed of sand, with a few bowlders, and is practically permanent. The current has a good velocity at all stages. The gage is read twice daily, by Harris Archer.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer, and the following measurement was made November 8: Width, 70 feet; area of section, 86 square feet; mean velocity, .85 feet per second; gage height 1.48 feet; discharge, 73 second-feet.

GUNPOWDER RIVER DRAINAGE BASIN.

The headwaters of Gunpowder River lie in York County, Pa., near the Maryland line. Thence the river flows southeasterly through Baltimore County, Md., and empties into Chesapeake Bay about 14 miles northeast of Baltimore. The river, although small, has steep

slopes, and the powers have considerable value on account of the small distance to a large city. A portion of the water supply for Baltimore is taken from this river at Loch Raven, and the city has purchased all power rights below this place. As the city increases in size it is probable that a larger proportion of the flow of the river will be taken. Little Gunpowder Falls, which is tributary below the fall line, has the same general characteristics as the larger river. Throughout its entire length it forms the boundary line between Harford and Baltimore counties, Md. There are several small power developments.

GUNPOWDER FALLS AT GLENCOE, MD.

This station was established on December 15, 1904, by F. H. Tillinghast. It is located at a steel highway bridge near the Pennsylvania Railroad station of Glencoe. A standard chain gage is attached to the upstream truss of the bridge. The length of the chain from the end of the weight to the marker is 22.13 feet. It is referenced by bench marks as follows: (1) Chiseled cross on downstream corner of left abutment; elevation, 18.30 feet. (2) Top of iron standard of gate at railroad crossing nearest bridge; elevation, 19.77 feet. The channel is straight for a distance of 300 feet above and 300 feet below the station. The bed is smooth and of sand, shifting slightly. The velocity of the current is good at all stages of the river. The gage is read twice daily by Samuel Wilhelm, the station agent at Glencoe.

The maintenance of this station during 1904 was under the direction of N. C. Grover, district hydrographer.

LITTLE GUNPOWDER FALLS NEAR BELAIR, MD.

This station was established on December 13, 1904, by F. H. Tillinghast. A standard chain gage is attached to a steel highway bridge on the road from Belair to Kingsville and at a distance of about 9 miles from Belair, from which place it is best reached by livery. The length of chain from the end of the weight to the marker is 13.36 feet. Its datum is referred to bench marks as follows: 1. Chiseled square on downstream end of right abutment; elevation, 13.36 feet. 2. Top of pulley wheel; elevation, 12.96 feet. The measurements are made from the upstream side of the bridge to which the gage is attached. The channel is straight for 300 feet above and 100 feet below the station. The bed is sand, with bowlders, and may shift slightly in the sand. The velocity of the current is good at all stages. There is a flood plain about 100 feet wide on the right bank. The gage is read twice daily by A. D. Unkart.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Little Gunpowder Falls, near Belair, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Dischar
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-f*
November 8 ...	N. C. Grover	33	27	1.22	1.40	
November 30 ..	.....do	27.5	30	1.27	1.46	

PATAPSCO RIVER DRAINAGE BASIN.

Patapsco River is formed by the junction of the North Branch a the South, or Piney Branch, near Mariottsville, Md., and flows i southeasterly direction into Chesapeake Bay 13 miles south of Ba more. Both branches rise in the central part of Maryland, and whole basin, which has an area of about 350 square miles, lies wit that State.

The river carries a small volume of water, but has considerable slo so that a large number of water powers have been developed along course. These, although small, are made valuable by their proxim to a large city.

The drainage basin is hilly and largely under cultivation. It no lakes or artificial reservoirs, and the flow of the stream is varial The maximum estimated flow at the gaging station at Woodsto Md., where the drainage area is 250 square miles, is about 12,(cubic feet per second, while the minimum estimated flow has b about 70 cubic feet per second. The record from which these e mates have been taken extends over a period of eight and o half years. The freshets do not, however, cause very large rises the water, because of the steep slope of the stream. The maxim recorded difference in gage height at Woodstock has been 13 f while the usual range within a year is about 3 or 4 feet.

The bed is generally rock. The banks are of rock and very li land is subject to overflow. The Baltimore and Ohio Railroad f lows the stream closely throughout nearly its entire length.

PATAPSCO RIVER AT WOODSTOCK, MD.

This station was established August 6, 1896, by E. G. Paul. ' original wire gage was destroyed when the bridge was repaired Ja ary 20–25, 1899. A new wire gage was established January 30, 1 on the same datum. A standard chain gage was installed by W. Sawyer, November 11, 1903, on the upper side of the bridge. ' datum was not changed. The length of the chain from the end of weight to the marker is 28.28 feet. The bench mark is a Un States Geological Survey standard copper bolt set in the face of

retaining wall at the entrance to the college grounds at the north end of the bridge. Its elevation is 22.06 feet above gage datum. Discharge measurements are made from the upper side of the iron highway bridge to which the gage is attached. It is located 1½ miles below the junction with the North Branch and near the railroad station. The initial point for soundings is near the right bank. The channel is straight for 150 feet above and several hundred feet below the station. At ordinary stages the river flows in one channel 100 feet wide; at high stages it flows in two channels 220 feet wide. The velocity is rapid. Both banks are high and are not subject to overflow. The right bank is without trees; the left is wooded. The bed of the stream is rough and is composed of bowlders and cobblestones. It is subject to slight change at extreme high water.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Patapsco River at Woodstock, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 12	Grover and Hoyt	102	89	2.02	3.91	180
September 30	E. C. Murphy	59	34	1.18	3.25	40
September 30 [a]	do	43	23	1.74	3.25	40

[a] Wading ¼ mile above.

Mean daily gage height, in feet, of Patapsco River at Woodstock, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.95	3.95	4.00	4.15	3.60	3.65	3.60	3.65	3.40	3.45	3.60	3.65
2	3.95	3.90	4.00	4.15	3.75	3.50	3.60	3.60	3.45	3.40	3.50	3.55
3	3.95	3.90	4.00	3.95	3.75	3.70	3.55	3.90	3.35	3.40	3.45	3.60
4	[a] 4.00	3.85	4.00	3.90	3.70	3.65	3.40	3.75	3.55	3.35	3.40	3.60
5	[a] 4.00	3.85	4.00	3.85	3.75	3.50	3.50	3.75	3.50	3.35	3.40	3.65
6	[a] 4.00	3.85	4.00	3.75	3.65	4.10	3.45	3.70	3.40	3.50	3.50	3.55
7	[a] 4.00	5.75	4.00	4.00	3.75	3.85	3.80	3.60	3.40	3.40	3.45	3.50
8	[a] 4.00	3.85	5.65	3.95	3.55	3.75	5.15	3.55	3.40	3.45	3.45	3.65
9	[a] 4.00	3.75	5.10	4.10	3.75	3.60	4.05	3.50	3.35	3.45	3.60	3.55
10	[a] 4.00	3.75	4.90	3.85	3.90	3.65	3.60	3.55	3.35	3.45	3.55	3.35
11	[a] 4.00	3.75	4.45	3.90	3.75	3.80	4.10	3.55	3.30	3.50	4.10	3.70
12	[a] 4.00	3.75	4.35	3.85	3.70	3.45	[b] 5.55	3.70	3.40	4.05	3.70	3.65
13	([a])	3.75	4.10	3.75	3.65	3.75	4.75	3.40	3.45	4.00	3.85	3.85
14	([a])	3.70	3.95	3.80	3.70	3.55	3.80	3.45	3.70	3.75	4.10	3.85
15	([a])	3.70	4.05	3.70	4.20	3.60	3.65	3.45	5.05	3.70	4.00	3.90
16	([a])	3.70	4.10	3.85	3.90	3.50	3.55	3.35	3.85	3.55	3.95	4.05
17	([a])	3.70	3.90	3.70	3.65	3.70	3.50	3.55	3.45	3.50	3.85	4.00
18	([a])	3.80	4.10	3.80	3.70	3.60	3.55	3.60	3.35	3.50	3.80	4.05
19	([a])	3.80	4.05	3.75	4.00	3.60	3.60	3.50	3.55	3.45	3.85	4.10
20	([a])	3.85	4.10	3.70	3.75	3.65	3.55	4.15	3.50	3.50	3.80	4.00
21	([a])	4.00	4.10	3.70	3.70	3.60	3.50	3.85	3.55	5.35	3.80	3.95
22	[c] 7.05	11.30	4.20	3.75	3.55	3.60	3.50	3.95	3.50	4.00	3.70	4.00

[a] Ice. [b] Maximum height 7.3. [c] Breaking up of ice. Maximum gage height 10.1.

Mean daily gage height, in feet, of Patapsco River at Woodstock, Md., for 1904—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
23	7.10	4.75	4.20	3.70	3.70	3.50	3.50	3.80	3.55	3.60	3.60	4.10
24	4.05	4.05	4.10	3.65	3.75	3.45	3.75	3.65	3.45	3.55	3.60	4.15
25	4.05	4.05	4.00	3.85	3.60	3.30	3.90	3.50	3.45	3.50	3.50	4.25
26	4.05	4.05	4.05	3.75	3.60	3.55	3.60	3.55	3.45	3.50	3.50	4.10
27	4.05	4.05	4.00	3.85	3.60	3.65	3.55	3.55	3.55	3.55	3.65	4.40
28	4.05	4.05	3.95	3.90	3.60	3.55	3.60	3.40	3.50	3.45	3.55	5.35
29	4.05	4.05	3.85	4.00	3.45	3.55	3.55	3.35	3.45	3.45	3.60	4.40
30	3.95	.....	3.95	3.80	3.55	3.50	3.60	3.40	3.50	3.45	3.60	4.20
31	4.00	.....	4.05	.....	3.75	.....	3.55	3.35	.....	3.60	.....	4.25

POTOMAC RIVER DRAINAGE BASIN.

Potomac River, which drains a total area of about 14,500 square miles, is formed by the junction of the North and South branches about 15 miles below Cumberland, Md., thence it pursues a southeasterly course, forming for its entire length the southerly boundary for the State of Maryland and the northerly boundaries for the States of West Virginia and Virginia, and empties into Chesapeake Bay.

The North Branch rises in the Alleghenies near the western corner of the State of Maryland, and the South Branch rises in the Alleghenies in Virginia and West Virginia. These branches, with their tributaries and the tributaries of the main stream as far down as Shenandoah River, drain a series of narrow and generally fertile valleys lying between the parallel ranges which make up the system of the Alleghenies in this region. Their slopes are not as a rule very large, and their beds are of gravel and sand. The slopes of their drainage basins are, however, generally very steep, and after a rain the water collects quickly in the rivers. There are few lowlands to overflow and no lakes whatever in the region, consequently these streams, and with them the Potomac River, are subject to very sudden and heavy freshets, while in dry seasons their discharge becomes small. The record of gage height at Point of Rocks, Md., covering a period of nearly ten years, shows a maximum range in gage height of 29 feet, and for several of the years the range has been more than 20 feet in each year. The corresponding maximum and minimum discharges have been estimated at 217,000 and 400 cubic feet per second, respectively.

The slopes of the tributary basin of Shenandoah River are, in many instances, steep, but the valley through which it flows is generally broader and more lands are subject to overflow. The slope of the river itself is usually greater than the slopes of the tributaries above mentioned. As a result the fluctuations in this stream are not so great, having a maximum range of about 19 feet at Millville in ten years, while the average annual fluctuation is 10 feet or less. The

charge in this period has ranged between 57,000 and 300 cubic feet · second.

From the junction of its two branches below Cumberland, Md., the tomac cuts through the mountains at nearly right angles. Its val- is narrow, its slope in many places great, the bed is generally vel and bowlders with ledge rock at a small depth, which often pears at the surface. The banks are generally high and not subject overflow. It crosses the fall line a few miles above Washington l reaches tidewater at Georgetown. As a water-power stream the ncipal disadvantage is the wide variability of its flow. All other iditions are favorable. A very insignificant amount of water power s been developed.

The Baltimore and Ohio Railroad follows the river for its entire gth, while the Shenandoah Valley Railroad and the Cumberland lley Railroad cross the stream. The Chesapeake and Ohio Canal lows it from Cumberland to Georgetown.

The United States Weather Bureau maintains river stations in this sin as follows:

Potomac at Cumberland, Md.
Potomac at Harpers Ferry, W. Va.
Shenandoah at Riverton, Va.

During 1904 the United States Geological Survey has maintained ging stations in this basin as follows:

Potomac at Point of Rocks, Md.
Potomac (North Branch) at Piedmont, W. Va.
Potomac (South Branch) at Springfield, W. Va.
Antietam at Sharpsburg, Md.
Shenandoah at Millville, W. Va.
Shenandoah (South Branch) at Front Royal, Va.
Shenandoah (North Branch) at Riverton, Va.
Monocacy at Frederick, Md.

POTOMAC RIVER (NORTH BRANCH) AT PIEDMONT, W. VA.

This station was established June 27, 1899, by E. G. Paul. It is cated at the iron highway bridge connecting Luke, Md., with Piedont, W. Va. The standard chain gage is attached to the hand rail the lower side of the bridge in the span next to the right bank. e length of the chain from the end of the weight to the marker is .87 feet. The bench mark is the top of a small shoulder in the face the sandstone ledge which forms the right abutment of the bridge. is about 4 feet above the ground and 10 feet downstream from the idge. The point is indicated by an arrow cut in the vertical face of e ledge. Its elevation is 20.40 feet above gage datum. Discharge easurements are made from the lower chord of the bridge to which e gage is attached, from the downstream side. The initial point for undings is the face of the pier on the right bank. The channel is

straight for 1,200 feet above and 600 feet below the station. The current has a moderate velocity. The right bank is high and rocky and will not overflow. The left bank is low and liable to overflow, but all water passes beneath the bridge. The bed of the stream is composed of gravel and cobblestones, is free from vegetation and is permanent. The gage is read twice each day by Charles H. Beck.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Potomac River (North Branch) at Piedmont, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 8	Hoyt & Hall	115	158	0.73	2.80	116
September 9	E. C. Murphy	50	21	.62	1.99	13
September 28	do	47	27	.74	1.99	20

Mean daily gage height, in feet, of Potomac River (North Branch) at Piedmont, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.90	3.20	4.70	4.70	4.45	3.95	3.00	2.35	1.90	2.00	2.00	2.10
2	2.95	3.05	4.55	5.25	4.20	3.85	3.10	2.55	1.90	2.00	2.00	2.05
3	3.00	3.10	4.85	4.75	3.95	3.80	3.05	2.40	2.00	2.05	2.05	2.20
4	3.55	3.05	5.55	4.35	3.85	3.70	2.85	2.40	1.85	2.00	2.10	2.30
5	3.10	3.05	4.40	4.15	3.75	3.80	2.70	2.40	2.00	1.95	2.10	2.20
6	2.95	3.10	4.20	4.00	3.65	3.90	2.65	2.65	2.10	1.95	2.00	2.20
7	3.15	6.20	4.65	3.90	3.60	3.75	2.70	2.25	1.90	2.00	2.10	2.25
8	3.00	6.10	5.55	3.90	3.50	3.60	2.80	2.20	1.90	2.15	2.10	2.20
9	2.90	4.70	4.70	4.30	3.50	3.50	2.80	2.05	1.95	2.10	2.10	2.05
10	2.80	4.05	4.30	4.15	3.60	3.60	3.45	2.15	2.10	2.10	2.10	2.00
11	2.80	3.80	4.25	3.95	3.45	3.50	3.20	2.20	2.00	2.15	2.20	2.10
12	2.80	3.60	4.30	3.85	3.35	3.40	3.05	2.20	2.00	2.20	2.20	2.10
13	2.70	3.25	4.05	3.85	3.20	3.25	2.90	2.20	2.00	2.40	2.20	2.20
14	2.70	3.35	3.95	3.70	3.20	3.20	2.80	2.20	2.00	2.25	2.20	2.30
15	2.60	3.45	3.85	3.70	3.40	3.20	2.70	2.15	2.05	2.20	2.20	2.30
16	2.60	3.25	3.65	3.75	3.40	3.00	2.60	2.15	2.10	2.15	2.20	2.30
17	2.60	3.05	3.55	3.90	3.20	3.10	2.50	2.20	2.10	2.10	2.20	2.30
18	3.15	3.00	3.85	3.80	3.70	3.00	2.45	2.10	2.10	2.05	2.20	2.30
19	3.00	3.10	3.95	3.70	5.95	2.90	2.35	2.10	2.10	2.10	2.30	2.30
20	2.95	3.00	4.10	3.60	5.00	3.00	2.35	2.15	2.00	2.10	2.30	2.30
21	3.80	3.20	4.50	3.50	5.00	3.05	2.50	2.20	2.10	2.20	2.30	2.30
22	[a]6.80	4.45	4.95	3.45	4.60	3.60	2.90	2.20	2.15	2.20	2.30	2.30
23	6.65	4.25	6.60	3.40	4.25	3.45	3.20	2.20	2.10	2.20	2.30	2.30
24	5.30	4.85	5.60	3.35	4.05	3.05	2.90	2.20	2.10	2.20	2.30	2.45
25	4.25	4.10	5.05	3.45	3.90	2.90	2.70	2.20	1.90	2.20	2.25	4.80
26	4.00	3.70	4.95	3.90	3.75	2.80	2.70	2.10	2.05	2.20	2.25	4.00
27	3.55	3.55	4.80	4.65	3.85	2.70	2.60	2.10	2.00	2.10	2.20	4.10
28	3.25	3.50	4.40	5.25	3.85	2.75	2.50	1.90	2.00	2.20	2.15	4.80
29	3.30	4.75	4.10	4.95	3.60	3.25	2.60	2.00	2.00	2.10	2.10	4.05
30	3.40	.....	4.00	4.55	3.50	3.05	2.50	2.00	2.00	2.00	2.10	3.20
31	3.25	.....	4.45	.....	3.50	.....	2.40	1.90	.....	2.10	.....	3.20

[a] Ice went out 1.05 p. m.

POTOMAC RIVER AT POINT OF ROCKS, MD.

This station was established by C. C. Babb, February 17, 1895, at ie steel highway bridge at Point of Rocks, Md. As originally placed, ie gage was located in the third span of the bridge from the north iore. The next year (1896) the wire became rusted and broke fre-ıently, and a new wire gage was placed on the lower side of the first ›an of the bridge and referred to a different datum. During 1897 ıere was a further change in the length of the wire of the gage, hich was not recorded, and therefore it has been necessary to discard ıe records during those two years—that is, 1896 and 1897. The ngth of the cable of the original wire gage was 44.22 feet. The easurements of 1895 are considered correct within themselves, but ıere was a difference between the datum of that gage and that of the resent standard of 0.4 foot, making it necessary to deduct that amount :om the gage readings of 1895 in order to reduce them to the present atum.

Since January 25, 1898, there has been no change in the datum of he gage. At that time it was referred to a bench mark, which is a :opper bolt in a large capstone on the lower wing wall of the north ıbutment, about 10 feet from the north end of the first iron truss and 41.75 feet above the datum of the gage. A second bench mark was established in July, 1904. It is a cross chiseled on the lower step of the upstream wing wall on the left bank of the river, being just across the towpath, 15 feet from the canal. Its elevation is 24 feet above gage datum.

A standard chain gage was installed at this station September 2, 1902, to take the place of the wire gage then in use. It is bolted to the guard rail on the lower side of the bridge in the second span from the left bank. The length of the chain from the end of the weight to the marker is 44.22 feet.

Discharge measurements are made from the eight span steel toll bridge to which the gage is attached. The initial point for soundings is the left end of the lower guard rail, 0.4 foot beyond the center of the end pin, on the downstream side of the bridge. The channel is straight for 500 feet above and 200 feet below the station. It is 1,300 feet wide, broken by 7 bridge piers. Both banks overflow only at extremely high water and are not wooded. In the two right spans the bed is composed of mud and is subject to some change; in the other spans the bed is composed of gravel and cobblestones and is permanent. The current does not flow at right angles with the bridge in all of the spans. The gage is read once each day by George H. Hickman.

The observations at this station during 1904 have been made under he direction of N. C. Grover, district hydrographer.

Discharge measurements of Potomac River at Point of Rocks, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per. sec.*	*Feet.*	*Second-feet.*
July 11	Hoyt and Grover	1,104	6,725	2.50	[a] 3.87	16,830

[a] Gage varied 0.82 during measurements.

Mean daily gage height, in feet, of Potomac River at Point of Rocks, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	3.0	5.3	2.4	5.6	6.7	1.4	1.4	0.9	0.6	0.6	0.8
2	1.5	2.9	4.4	2.6	4.0	7.8	1.3	1.3	.8	.6	.6	.8
3	2.0	2.9	4.0	3.0	3.6	5.2	1.3	1.2	.8	.6	.7	.8
4	2.3	3.3	3.8	3.5	3.0	4.6	1.3	1.2	.8	.6	.7	.8
5	1.8	4.8	4.0	3.1	2.8	4.1	1.2	1.2	.9	.6	.7	.8
6	1.5	4.9	4.2	3.5	2.6	5.0	1.5	1.2	1.0	.6	.7	.8
7	1.5	4.9	4.5	3.0	2.5	4.4	1.5	1.3	.9	.6	.7	.8
8	1.5	3.3	5.0	2.4	2.8	4.0	1.6	1.4	.8	.6	.7	.8
9	1.6	3.5	4.8	2.3	2.7	3.6	1.6	1.5	.7	.5	.7	.8
10	1.6	5.7	5.4	2.3	2.6	3.2	1.7	1.4	.7	.5	.7	.9
11	1.6	5.0	4.5	2.6	2.5	2.8	2.9	1.3	.7	.5	.7	.9
12	1.7	3.9	3.8	3.1	2.5	2.6	2.6	1.3	.8	.6	.7	.9
13	1.6	3.6	3.3	2.8	2.4	2.5	3.4	1.2	1.0	.7	.7	.9
14	1.6	3.5	2.8	2.6	2.3	2.4	3.1	1.2	.9	.7	.8	.9
15	1.6	3.4	2.6	2.5	2.2	2.2	3.0	1.1	.9	.6	.8	.9
16	1.5	3.8	2.4	2.2	2.2	2.1	2.8	1.1	1.0	.6	.8	.9
17	1.5	3.8	2.4	2.1	2.1	2.0	2.4	1.1	1.0	.5	.7	.9
18	1.5	3.9	2.2	2.1	2.2	1.8	2.0	1.0	.9	.5	.8	.9
19	1.5	3.9	2.1	2.0	2.3	1.6	1.8	1.0	.8	.5	.8	.9
20	1.5	3.8	2.2	1.9	3.1	1.5	1.6	1.0	.7	.6	.8	1.0
21	1.5	3.8	2.3	1.9	6.2	1.5	1.4	1.0	.8	1.0	.7	1.0
22	2.0	4.5	2.4	1.8	4.7	2.5	1.4	.9	1.0	.9	.7	1.0
23	4.0	5.6	2.5	1.7	4.0	3.0	1.3	.9	.9	.8	.7	1.0
24	5.2	6.0	2.7	1.7	3.6	2.8	1.3	1.0	.8	.7	.7	1.0
25	[a] 7.4	6.6	3.7	1.6	3.1	2.5	1.3	1.0	.8	.7	.7	1.1
26	5.1	6.6	3.4	1.5	2.8	2.1	1.4	2.0	.8	.7	.7	1.4
27	3.6	7.6	3.0	1.6	2.5	1.7	1.4	1.1	.7	.7	.7	1.5
28	3.3	6.6	2.8	2.0	2.4	1.5	1.4	1.1	.7	.7	.7	1.8
29	3.2	6.0	2.6	3.7	2.3	1.5	1.5	1.0	.7	.6	.8	1.8
30	3.0	.....	2.5	6.3	2.2	1.4	1.5	1.0	.7	.6	.8	1.9
31	3.0	.....	2.4	.....	2.4	.....	1.5	.9	.....	.6	.....	2.0

[a] Ice gorge caused river to rise.

: for Potomac River at Point of Rocks, Md., from January 1 to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1,300	1.80	5,590	3.00	11,455	5.20	23,660
1,345	1.90	6,070	3.10	11,950	5.40	24,970
1,445	2.00	6,550	3.20	12,450	5.60	26,320
1,640	2.10	7,035	3.40	13,470	5.80	27,710
1,900	2.20	7,520	3.60	14,500	6.00	29,140
2,200	2.30	8,005	3.80	15,550	6.50	32,790
2,550	2.40	8,490	4.00	16,620	7.00	36,440
2,935	2.50	8,980	4.20	17,710	7.50	40,290
3,340	2.60	9,475	4.40	18,820	8.00	44,140
3,760	2.70	9,970	4.60	19,970	9.00	52,240
4,195	2.80	10,465	4.80	21,160	10.00	60,540
4,645	2.90	10,960	5.00	22,390	11.00	68,940
5,110						

e table is applicable only for open-channel conditions. It is based upon ıeasurements made during 1900 to 1904, inclusive. It is not very well bove gage height 10 feet the rating curve is a tangent, the difference er tenth.

ed monthly discharge of Potomac River at Point of Rocks, Md., for 1904.

[Drainage area, 9,654 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	39,520	4,195	8,757	0.907	1.05
.....	41,060	10,960	20,180	2.09	2.25
.....	24,970	7,035	13,460	1.39	1.60
.....	31,330	4,195	9,270	.960	1.07
.....	30,600	7,035	11,540	1.20	1.38
.....	42,600	3,760	12,120	1.26	1.41
.....	13,470	2,935	5,612	.581	.670
.....	6,550	1,900	2,872	.297	.342
.....	2,200	1,445	1,742	.180	.201
.....	2,200	1,300	1,414	.146	.168
.....	1,640	1,345	1,490	.154	.172
.....	6,550	1,640	2,550	.264	.304
'ear	42,600	1,300	7,584	.786	10.617

POTOMAC RIVER (SOUTH BRANCH) NEAR SPRINGFIELD, W. VA.

A gaging station was established at the Baltimore and Ohio Railroad bridge, 3 miles southwest of Springfield, by C. C. Babb, in April, 1894. This station was discontinued in 1896 for want of an observer. On June 26, 1899, a station was established by E. G. Paul at the highway bridge 1½ miles below the original station, near Grace Station. This bridge was carried away by flood in February, 1902. The present station was established August 28, 1903, by E. G. Paul. It is located at the steel highway bridge 2½ miles east of Springfield, W. Va. The bridge has two spans of 150 feet each. During high water the river flows beneath both spans, but at low stages the stream flows beneath the left span only. There is a dam located about 2 miles above the station, and a small island above and also one below. A standard chain gage is located in the center of the left span on the downstream side of the bridge. The length of chain from the end of the weight to the marker is 34.76 feet. Bench mark No. 1 is a nail in a large sycamore tree, 15 feet downstream from the left approach to the bridge. The nail is in the side of the tree away from the river and about 6 feet above the ground. Its elevation is 18.80 feet above gage datum. Bench mark No. 2 is a nail in a large willow tree on the left bank of the river, about 65 feet upstream from the bridge. It is in the side of the tree away from the river and about 2½ feet above the ground. Its elevation is 14.52 feet above gage datum. The initial point for soundings is the river face of the left abutment at the downstream side of the bridge. The channel is straight for several hundred feet above and below the station. Both banks are low and liable to overflow. The bed of the stream is of gravel. The gage is read twice each day by Miss Olivia Blue.

The observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Potomac River (South Branch) near Springfield, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 9	Hoyt & Hall	143	312	.79	2.50	248
September 9	E. C. Murphy	122	211	.54	2.00	115
September 29	do	108	65	2.05	1.99	[a] 133

[a] Below regular station by wading.

Mean daily gage height, in feet, of Potomac River (South Branch) near Springfield, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 2.60	2.80	3.75	3.65	5.40	3.45	2.80	2.40	2.00	1.80	1.80	1.80
2	[a] 2.60	2.80	4.60	4.05	4.85	3.50	2.65	2.50	2.00	1.80	1.80	1.80
3	[a] 2.60	2.80	4.20	3.95	4.35	3.45	2.60	2.70	2.00	1.80	1.80	1.80
4	[a] 2.60	2.70	4.35	3.70	4.15	3.40	2.60	2.80	2.00	1.80	1.80	1.90
5	[a] 2.60	2.60	4.10	3.50	3.90	4.35	2.60	2.80	2.00	1.80	1.80	1.90
6	[a] 2.60	2.60	3.65	3.35	3.65	4.30	2.50	2.60	2.00	1.85	1.80	1.90
7	[a] 2.60	3.00	3.45	3.20	3.30	3.90	2.50	2.60	2.00	1.85	1.80	1.90
8	[a] 2.60	[b] 6.40	5.55	3.20	3.50	3.80	2.60	2.55	2.00	1.80	1.80	1.90
9	[a] 2.60	4.85	5.60	3.15	3.40	3.35	2.50	2.50	2.10	1.80	1.80	1.95
10	[a] 2.60	3.55	4.60	3.20	3.60	3.10	2.85	2.40	2.15	1.80	1.90	2.00
11	[a] 2.60	3.20	4.05	3.30	3.40	2.95	4.50	2.30	2.10	1.80	1.90	2.00
12	[a] 2.60	2.70	3.85	3.25	3.25	3.10	3.85	2.25	2.10	1.80	1.90	2.20
13	[a] 2.60	2.85	3.65	3.20	3.10	3.10	3.50	2.20	2.10	1.80	1.90	2.20
14	[a] 2.60	2.95	3.50	3.20	3.00	3.00	2.95	2.10	2.20	1.80	1.90	2.20
15	[a] 2.60	3.05	3.35	3.00	3.00	2.70	2.85	2.10	2.15	1.80	1.90	2.20
16	[a] 2.60	2.95	3.15	2.85	3.00	2.95	2.55	2.10	2.05	1.80	1.90	2.20
17	[a] 2.60	2.90	3.10	2.80	3.00	2.85	2.45	2.00	2.00	1.80	1.80	2.20
18	2.60	2.65	3.10	3.00	3.25	3.10	2.50	2.00	2.00	1.80	1.80	2.20
19	2.60	2.95	3.10	3.00	8.05	3.00	2.55	2.00	2.00	1.80	1.80	[a] 2.10
20	2.60	2.90	3.05	3.00	7.95	5.65	2.60	2.00	1.90	1.80	1.80	2.10
21	2.60	2.95	3.05	3.00	6.30	4.70	2.70	2.00	1.90	1.90	1.80	2.10
22	2.85	3.50	3.40	2.90	5.40	3.95	2.60	2.00	1.90	1.90	1.80	2.10
23	9.05	4.50	3.90	2.80	4.80	3.60	2.80	2.00	1.90	1.90	1.80	2.10
24	5.40	4.05	4.55	2.80	4.30	3.45	2.90	2.00	1.90	1.90	1.80	2.10
25	4.05	3.00	4.45	2.70	3.95	3.20	2.80	2.00	1.80	1.80	1.80	2.20
26	3.45	3.25	4.15	2.80	3.75	2.90	2.50	2.00	1.80	1.80	1.80	2.25
27	3.00	2.95	3.95	3.05	3.80	2.75	2.70	2.00	1.80	1.80	1.80	2.50
28	[c] 2.90	2.95	3.80	8.60	4.20	2.55	2.60	1.90	1.80	1.80	1.80	2.85
29	2.65	2.95	3.45	8.10	3.65	2.75	2.50	2.10	1.80	1.80	1.80	3.50
30	2.75	.....	3.45	6.60	3.45	2.90	2.40	2.10	1.80	1.80	1.80	3.90
31	[c] 2.90	.....	3.35	.....	3.45	.....	2.40	2.00	.....	1.80	.....	3.90

[a] Frozen over. [b] Ice going out. [c] Slush ice.

ANTIETAM CREEK NEAR SHARPSBURG, MD.

Antietam Creek rises in the western part of Maryland and flows in a southerly direction, entering the Potomac 10 miles above Harpers Ferry. Its drainage area is mostly of a hilly character and is largely cultivated. This station was established June 24, 1897, by A. P. Davis. It is located a few hundred feet below the bridge on the toll road from Sharpsburg to Keedysville, Md. There is an old dam, not now in use, just below the bridge. The gage is a vertical rod driven into the gravel of the stream bed and spiked to a tree on the left bank near the cable. The bench mark is a copper bolt set in a ledge of rock on the left bank, at a point about 125 feet above the cable. Its elevation is 16.34 feet above gage datum. Discharge measurements are made from a steel-wire cable, which is supported by the forks of sycamore trees on each bank and is anchored to timbers set in the ground. A tagged wire is suspended above the cable. The initial point for soundings is a staple in the tree on the left bank. The channel is straight for 300 feet above

and below the station. It has a width at ordinary stages of about 100 feet; is shallow and unobstructed. There is a good measurable velocity at all stages. The right bank is low and liable to overflow; the left bank is high and rocky, and both are fringed with trees. The bed of the stream is composed of gravel, free from vegetation, and is permanent. There is but one channel at all stages. The gage is read once each day by Charles E. Hammond, the toll gatherer.

The observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Antietam Creek near Sharpsburg, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 1	Hoyt and Hall	85	154	1.03	1.79	158
July 11	Hoyt and Grover	90	159	.94	1.79	150

Mean daily gage height, in feet, of Antietam Creek near Sharpsburg, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	.....	.....	.....	.....	.....	.....	1.60	1.50	1.45	1.50	1.45
2	1.90	.....	.....	.....	.....	.....	.....	1.60	1.50	1.45	1.50	1.45
3	1.75	.....	.....	.....	.....	.....	.....	1.80	1.50	1.40	1.45	1.45
4	2.10	.....	.....	.....	.....	.....	.....	1.65	1.60	1.55	1.50	1.45
5	1.90	.....	.....	.....	.....	.....	.....	1.60	1.55	1.50	1.50	1.40
6	1.90	.....	.....	.....	.....	.....	.....	1.60	1.50	1.45	1.45	1.30
7	1.80	.....	.....	.....	.....	.....	.....	1.60	1.45	1.50	1.40	1.45
8	1.80	.....	.....	.....	.....	.....	.....	1.50	1.55	1.45	1.50	1.45
9	1.80	.....	.....	.....	.....	.....	.....	1.50	1.45	1.45	1.50	1.45
10	1.85	.....	.....	.....	.....	.....	.....	1.50	1.85	1.50	1.50	1.50
11	1.85	.....	.....	.....	.....	.....	.....	3.00	1.60	1.50	1.50	1.55
12	1.90	.....	.....	.....	.....	.....	2.20	1.80	1.55	1.50	1.50	1.40
13	1.85	.....	.....	.....	.....	.....	2.20	1.65	1.50	1.75	1.60	1.60
14	1.85	.....	.....	.....	.....	.....	1.90	1.55	1.65	1.60	1.50	1.50
15	1.70	.....	.....	.....	.....	.....	1.75	1.60	1.65	1.50	1.65	1.45
16	1.70	.....	.....	.....	.....	.....	1.70	1.60	1.80	1.45	1.50	1.55
17	1.70	.....	.....	.....	.....	.....	1.70	1.60	1.60	1.40	1.50	1.55
18	1.80	.....	.....	.....	.....	.....	1.70	1.60	1.50	1.50	1.40	1.55
19	1.80	.....	.....	.....	.....	.....	1.70	1.65	1.40	1.50	1.40	1.55
20	1.80	.....	.....	.....	.....	.....	1.60	1.60	1.65	1.50	1.50	1.60
21	1.85	.....	.....	.....	.....	.....	1.65	1.60	1.60	1.65	1.50	1.65
22	3.90	.....	.....	.....	.....	.....	1.60	1.60	1.60	1.95	1.55	1.65
23	[a] 6.00	.....	.....	.....	.....	.....	1.70	1.85	1.55	1.65	1.55	1.55
24	.....	.....	.....	.....	.....	.....	1.75	1.75	1.50	1.60	1.50	1.60
25	.....	.....	.....	.....	.....	.....	1.85	1.60	1.45	1.50	1.55	1.65
26	.....	.....	.....	.....	.....	.....	1.70	1.60	1.50	1.55	1.50	1.75
27	.....	.....	.....	.....	.....	.....	1.60	1.55	1.55	1.50	1.45	1.70
28	.....	.....	.....	.....	.....	.....	1.60	1.45	1.50	1.50	1.35	1.80
29	.....	.....	.....	.....	.....	.....	1.85	1.50	1.50	1.55	1.45	2.15
30	.....	.....	.....	.....	.....	.....	1.70	1.50	1.45	1.45	1.50	2.05
31	.....	.....	.....	.....	.....	.....	1.60	1.50	.....	1.50	.....	1.75

[a] Ice carried gage away; reestablished July 12.

ating table for Antietam Creek near Sharpsburg, Md., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.35	90	2.30	298	3.30	720	4.30	1,270
1.40	95	2.40	332	3.40	775	4.40	1,325
1.50	108	2.50	367	3.50	830	4.50	1,380
1.60	121	2.60	402	3.60	885	4.60	1,435
1.70	137	2.70	440	3.70	940	4.70	1,490
1.80	155	2.80	482	3.80	995	4.80	1,545
1.90	179	2.90	525	3.90	1,050	5.00	1,655
2.00	206	3.00	570	4.00	1,105	6.00	2,205
2.10	234	3.10	615	4.10	1,160	7.00	2,755
2.20	265	3.20	665	4.20	1,215		

The above table is applicable only for open-channel conditions. It is based upon 12 ischarge measurements made during 1898 to 1904, inclusive. It is well defined etween gage heights 1.60 feet and 3.50 feet. The table has been extended beyond ıese limits. Above gage height 3.20 feet the rating curve is a tangent, the differnce being 55 per tenth.

Estimated monthly discharge of Antietam Creek near Sharpsburg, Md., for 1904.

[Drainage area, 293 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January 1–23	2,205	137	292	0.997	0.853
July 12–31	265	121	151	.515	.383
August	570	102	137	.468	.540
September	167	95	116	.396	.442
October	193	95	113	.386	.445
November	129	90	107	.365	.407
December	250	95	123	.420	.484

SHENANDOAH RIVER AT MILLVILLE, W. VA.

This station was established April 15, 1895, by C. C. Babb. It is ocated about one-fourth mile above the Baltimore and Ohio Railroad tation at Millville, W. Va. It is best reached by driving from Harers Ferry, W. Va. The vertical gage is spiked to a large sycamore ree on the left bank a few hundred feet downstream from the cable.

Bench mark No. 1 is a copper plug in the upstream side of the base of the second tree downstream from the gage. Its elevation is 6.68 feet above the zero of the gage. Bench mark No. 2 is the upper surface of the head of a wire nail driven horizontally in a blaze on the base of the first tree upstream from the gage. Its elevation is 7.42 feet above the zero of the gage. Bench mark No. 3 is the upper surface of the head of a wire spike driven in a blaze on the tree to which the gage is fastened on the side away from the river; elevation 9.43 feet. Discharge measurements are made from a three-fourths inch cable from which is suspended a car. The cable, which is suspended over the branches of two large sycamore trees and is securely anchored to the bank at both ends, has a total span of 500 feet. The initial point for soundings is the side of a tree nearest the river at the cable on the left bank. The channel is straight for several hundred feet above and below the station, and the current is swift and unobstructed. Both banks are low, liable to overflow, and are without trees. There is but one channel at all stages. The bed of the stream is composed of mud and rocks. The gage is read once each day by W. R. Nicewarner, the railroad station agent.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Shenandoah River at Millville, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 13	F. H. Brundage	500	1,771	1.06	1.70	1,883
July 4	Hoyt and Hall	505	1,578	.72	1.20	1,137
July 10	Hoyt and Grover	499	1,561	.88	1.34	1,371
September 28	E. C. Murphy	490	1,147	.49	.50	564
October 20	do	485	1,126	.44	.41	494

Mean daily gage height, in feet, of Shenandoah River at Millville, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.80	(a)	(a)	1.80	3.30	4.00	1.50	1.15	0.60	0.45	0.45	0.45
2	.85	(a)	(a)	1.80	3.30	2.60	1.40	1.05	.60	.40	.45	.45
3	1.20	(a)	(a)	1.75	2.70	2.33	1.30	1.10	.60	.40	.40	.50
4	1.20	(a)	(a)	1.70	2.40	2.10	1.20	1.25	.60	.40	.50	.50
5	1.00	(a)	(a)	1.60	2.15	2.60	1.10	1.40	.60	.40	.45	.50
6	1.00	(a)	(a)	1.50	2.10	2.85	1.20	1.40	.60	.40	.45	.55
7	1.10	(a)	(a)	1.50	1.95	4.00	1.15	1.70	.60	.45	.45	.50
8	1.10	(a)	2.30	1.50	2.00	2.90	1.30	1.80	.60	.45	.45	.50
9	1.30	(a)	4.90	1.60	2.00	2.40	1.25	1.45	.55	.40	.40	.50
10	1.20	(a)	3.50	1.70	2.30	2.15	1.35	1.40	.55	.40	.40	.50
11	1.20	(a)	3.00	2.45	2.50	2.00	5.60	1.35	.50	.40	.50	.85

a No observation, gage broken down by ice.

ean daily gage height, in feet, of Shenandoah River at Millville, W. Va., for 1904—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.10	(a)	2.50	2.40	2.45	1.85	3.70	1.40	0.50	0.50	0.45	0.50
.....	1.10	(a)	2.30	2.20	2.30	1.75	2.80	1.35	.60	.50	.50	.65
.....	1.00	(a)	2.00	2.00	2.05	1.50	2.10	1.30	.60	.55	.60	.65
.....	1.00	(a)	1.90	1.75	1.90	1.40	1.75	1.10	.90	.50	.60	.75
.....	1.00	(a)	1.80	1.65	1.85	1.35	1.50	1.05	.90	.50	.50	.60
.....	1.00	(a)	1.75	1.60	1.80	1.40	1.40	1.00	.80	.50	.50	1.65
.....	1.00	(a)	1.70	1.55	1.80	1.65	1.30	1.00	.75	.50	.50	1.80
.....	1.00	(a)	1.60	1.45	1.90	1.40	1.30	.95	.70	.50	.55	1.55
.....	1.10	(a)	1.50	1.45	2.30	1.35	1.20	.90	.65	.45	.50	.80
.....	1.30	(a)	1.45	1.30	3.50	1.60	1.20	.90	.60	.60	.50	.70
.....	1.60	(a)	1.50	1.25	2.95	1.70	1.20	.85	.65	.60	.50	.70
.....	2.30	(a)	1.60	1.20	2.45	1.90	1.15	.90	.60	.60	.50	.70
.....	2.60	(a)	1.60	1.15	2.15	1.60	1.10	.80	.55	.55	.50	.70
.....	(a)	(a)	1.65	1.10	2.00	1.45	1.20	.90	.50	.50	.50	.80
.....	(a)	(a)	1.80	1.10	1.95	1.30	1.30	.80	.50	.50	.45	1.15
.....	(a)	(a)	1.85	1.30	2.30	1.20	1.20	.75	.50	.45	.45	1.10
.....	(a)	(a)	1.80	2.50	1.95	1.15	1.10	.70	.50	.40	.45	1.30
.....	(a)	(a)	1.75	4.30	1.70	1.10	1.10	.60	.50	.40	.45	2.25
.....	(a)	.....	1.70	3.85	1.70	1.60	1.25	.55	.45	.40	.45	1.20
.....	(a)	.....	1.70	.....	1.55	.....	1.10	.60	.....	.40	.....	1.10

a No observation, gage broken down by ice.

The gage heights were affected by ice conditions during latter half of December.

ating table for Shenandoah River at Millville, W. Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	475	1.70	1,865	3.00	4,560	4.30	8,105
.50	540	1.80	2,025	3.10	4,805	4.40	8,415
.60	610	1.90	2,200	3.20	5,055	4.50	8,730
.70	685	2.00	2,395	3.30	5,305	4.60	9,045
.80	765	2.10	2,590	3.40	5,560	4.70	9,360
.90	850	2.20	2,790	3.50	5,820	4.80	9,680
1.00	945	2.30	2,990	3.60	6,085	4.90	10,000
1.10	1,055	2.40	3,200	3.70	6,355	5.00	10,320
1.20	1,170	2.50	3,410	3.80	6,630	6.00	13,520
1.30	1,295	2.60	3,630	3.90	6,910	7.00	16,720
1.40	1,430	2.70	3,860	4.00	7,195	8.00	19,920
1.50	1,570	2.80	4,090	4.10	7,490	9.00	23,120
1.60	1,715	2.90	4,320	4.20	7,795		

The above table is applicable only for open-channel conditions. It is based upon scharge measurements made during 1895 to 1904, inclusive, special weight being ven to 1904 measurements. It is fairly well defined between gage heights 0.40 feet d 7 feet. The table has been extended beyond these limits. Above gage height 70 feet the rating curve is a tangent, the difference being 320 per tenth.

Estimated monthly discharge of Shenandoah River at Millville, W. Va., for 1904.

[Drainage area, 2,995 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January 1–24	3,630	765	1,251	0.418	0.373
March 8–31	10,000	1,500	2,651	.885	.790
April	8,105	1,055	2,205	.736	.821
May	5,820	1,643	2,916	.974	1.12
June	7,195	1,055	2,463	.822	.917
July	12,240	1,055	1,910	.638	.736
August	2,025	575	1,075	.359	.414
September	850	508	617	.206	.230
October	610	475	519	.173	.199
November	610	475	527	.176	.196
December	2,890	508	892	.298	.344

SHENANDOAH RIVER (SOUTH BRANCH) NEAR FRONT ROYAL, VA.

This station was established June 26, 1899, by A. P. Davis. It is located about 1 mile above the ford, which is near the Norfolk and Western Railroad station. This railroad follows the right bank of the stream. The gage is a vertical timber spiked to a large sycamore tree on the left bank about 800 feet upstream from the cable. Bench mark No. 1 is a headless spike on the river side of an elm tree on the left bank, 8 feet downstream from the gage. It is 1½ feet above ground and has an elevation of 10.49 feet above the zero of the gage. Bench mark No. 2 is nail driven horizontally into the downstream side of the stump of a large sycamore tree 270 feet downstream from the gage. It is 0.5 foot above the ground and is immediately below a blaze. Its elevation is 14.55 feet above the zero of the gage. Discharge measurements are made from a cable, which has a span of 300 feet and is suspended over the branches of two large sycamore trees, with its right end fastened to the tree and its left end anchored in the ground. The initial point for soundings is on the main cable 0.5 foot from the tree on the left bank. The channel is straight for 600 feet above and below the station and the current is sluggish. The river may overflow the right bank, but will not overflow the railroad embankment a few feet back from the river, except at extreme flood stages. The left bank is low, liable to overflow, and is fringed with trees. The bed of the stream is composed partly of rock and partly of sand, and is liable to shift in places. The gage is read twice each day by Miss Brentie Johnson.

ween January 25 and June 30, 1904, the stage of river was ′ed by means of temporary gages set by the observer, and con- ıtly the record between those dates is approximate.

observations at this station during 1904 have been made under rection of N. C. Grover, district hydrographer.

ge measurements of Shenandoah River (South Branch) near Front Royal, Va., in 1904.

ıte.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
.....	F. H. Brundage.....	310	846	1.35	4.79	1,140
).....	Hoyt and Hall.....	310	936	.97	4.55	906
ber 27 ..	E. C. Murphy	274	509	.77	3.50	390
r 19.....	.....do	275	516	.64	3.42	331

aily gage, in feet, of Shenandoah River (South Branch) near Front Royal, Va., for 1904.

y.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	6.44	5.69	4.84	5.19	6.39	4.94	4.50	4.10	3.60	3.40	3.42	3.45
.....	6.24	5.59	4.84	5.04	5.84	5.04	4.40	4.05	3.60	3.40	3.40	3.39
.....	6.24	5.79	5.04	4.84	5.44	5.29	4.30	4.10	3.60	3.40	3.40	3.50
.....	6.54	5.74	4.94	4.69	5.14	6.19	4.20	4.30	3.60	3.40	3.40	[a]3.50
.....	6.54	5.74	5.04	4.64	5.09	6.44	4.10	4.40	3.60	3.40	3.42	3.50
.....	6.29	5.49	4.99	4.59	4.99	6.49	4.10	4.50	3.65	3.40	3.40	3.45
.....	6.19	5.54	5.04	4.59	4.99	5.99	4.05	4.70	3.70	3.40	3.43	3.41
.....	6.09	6.34	6.29	4.59	4.99	5.39	4.00	4.45	3.70	3.40	3.45	3.45
.....	6.04	6.14	6.39	4.69	5.14	5.04	4.20	4.40	3.70	3.40	3.50	3.45
.....	5.94	6.34	6.69	5.24	5.69	4.94	5.50	4.75	3.70	3.40	3.42	3.51
.....	5.89	6.34	5.99	5.74	5.84	4.74	7.90	4.60	3.70	3.40	3.40	4.15
.....	5.99	6.19	5.74	5.69	5.64	4.69	7.40	4.50	3.70	3.45	3.40	[b]4.40
.....	5.99	5.09	5.54	5.34	5.34	4.64	5.40	4.40	3.70	3.55	3.40	4.60
.....	6.04	5.99	5.19	5.14	5.24	4.54	4.75	4.20	3.65	3.45	3.55	4.80
.....	5.89	5.89	5.09	4.94	4.89	4.49	4.55	4.15	4.20	3.40	3.50	3.95
.....	5.74	5.89	4.99	4.84	4.89	4.39	4.40	4.10	3.95	3.40	3.52	4.10
.....	5.74	5.84	4.89	4.79	4.89	4.59	4.35	4.00	3.70	3.40	3.50	4.10
.....	5.79	5.89	4.89	4.64	5.29	4.64	4.30	4.00	3.60	3.40	3.45	4.20
.....	5.89	5.09	4.89	3.54	5.69	4.39	4.35	3.90	3.60	3.40	3.45	3.90
.....	5.84	6.24	4.69	4.49	7.59	4.54	4.25	3.80	3.60	3.45	3.40	3.90
.....	5.84	6.34	4.69	4.49	6.74	4.99	4.10	3.80	3.50	3.55	3.42	3.70
.....	6.39	6.89	4.69	4.39	5.89	5.14	4.10	3.75	3.50	3.50	3.40	3.70
.....	8.24	8.39	4.94	4.39	5.44	5.04	4.00	3.65	3.50	3.45	3.43	3.87
.....	9.64	8.64	4.94	4.29	5.24	4.74	4.30	3.60	3.50	3.40	3.43	3.95
.....	7.24	7.69	4.94	4.39	5.09	4.39	4.40	3.60	3.50	3.40	3.42	3.90
.....	6.54	6.14	5.04	4.44	4.99	4.29	4.30	3.55	3.50	3.40	3.40	3.80
.....	6.29	6.34	5.09	5.49	4.94	4.34	4.20	3.50	3.40	3.42	3.40	3.95
.....	6.14	5.74	5.09	6.24	4.89	4.39	4.35	3.50	3.40	3.40	3.40	3.90
.....	5.94	5.19	4.99	6.79	4.89	4.69	4.15	3.50	3.40	3.40	3.40	4.50
.....	5.84	.....	5.21	6.64	4.79	4.52	4.20	3.55	3.40	3.40	3.40	4.20
.....	5.74	.....	5.29	.....	4.79	.....	4.20	3.60	.....	3.40	.....	4.00

[a] Ice running in river. [b] River frozen entirely across.

heights are approximate from January 25 to March 1.

Rating table for Shenandoah River (South Branch) near Front Royal, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.30	305	4.70	1,045	6.10	2,665	7.50	5,080
3.40	330	4.80	1,130	6.20	2,815	7.60	5,260
3.50	359	4.90	1,220	6.30	2,970	7.70	5,440
3.60	392	5.00	1,315	6.40	3,130	7.80	5,620
3.70	429	5.10	1,420	6.50	3,295	7.90	5,800
3.80	470	5.20	1,530	6.60	3,465	8.00	5,980
3.90	515	5.30	1,640	6.70	3,640	8.20	6,340
4.00	565	5.40	1,755	6.80	3,820	8.40	6,700
4.10	615	5.50	1,870	6.90	4,000	8.60	7,060
4.20	670	5.60	1,990	7.00	4,180	8.80	7,420
4.30	735	5.70	2,115	7.10	4,360	9.00	7,780
4.40	805	5.80	2,245	7.20	4,540	9.50	8,680
4.50	880	5.90	2,380	7.30	4,720	10.00	9,580
4.60	960	6.00	2,520	7.40	4,900		

The above table is applicable only for open-channel conditions. It is based upon seven discharge measurements made during 1900 to 1904, inclusive. It is well defined between gage heights 3.40 feet and 8 feet. The table has been extended beyond these limits. Above gage height 7 feet the rating curve is a tangent, the difference being 180 per tenth.

Estimated monthly discharge of Shenandoah River (South Branch) near Front Royal, Va., for 1904.

[Drainage area, 1,569 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	8,932	2,167	3,031	1.93	2.23
February	7,132	1,410	2,840	1.81	1.95
March	3,623	1,037	1,571	1.00	1.15
April	3,802	728	1,403	.894	.997
May	5,242	1,122	1,802	1.15	1.33
June	3,279	728	1,332	.849	.947
July	5,800	565	1,089	.694	.800
August	1,088	359	614	.391	.451
September	670	330	402	.256	.286
October	376	330	336	.214	.247
November	376	330	339	.216	.241
December	1,130	328	534	.340	.392
The year	8,932	328	1,274	.812	11.02

SHENANDOAH RIVER (NORTH BRANCH) NEAR RIVERTON, VA.

This station was established June 26, 1899, by A. P. Davis. It is located about 2 miles above Riverton, Va., a short distance from the Southern Railway station. It is most easily reached by driving from Front Royal, Va. The vertical gage rod is spiked to timber and to a sycamore tree on the left bank about 100 feet above the cable station. Bench mark No. 1 is a wire nail driven into a pear tree and is located near the fence and 150 feet from the left bank of the river. Its elevation above the zero of the gage is 26.75 feet. Bench mark No. 2 is formed by three wire nails driven flush in the surface of a stump 50 feet downstream from the fence line of the road, at the edge of the field, on the side toward the river. Its elevation is 20.44 feet above the zero of the gage. The original gage was a vertical timber bolted to a large sycamore tree on the right bank. On September 10, 1900, the gage was moved to the left bank and its datum was lowered 1 foot, causing all readings to be increased by 1 foot. The gage at this station washed out in the flood of February 22, 1902, and the station was temporarily abandoned until August 17, 1902, when it was reestablished by E. G. Paul, the zero of the new gage being at the same elevation as the zero of the former gage. Discharge measurements are made by means of a cable, car, and tagged wire just above the ford. The cable has a span of 260 feet, is supported by timbers, and anchored in the ground at each end. The initial point for soundings is 0.5 foot from the timber which supports the tag wire on the left bank. The channel is straight for 600 feet above and below the station. The current has a moderate velocity. Both banks are low and liable to overflow, with a fringe of trees along each bank. The bed of the stream is rocky, permanent, and free from vegetation. There is but one channel at all stages. The gage is read twice each day by L. W. Burke.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Shenandoah River (North Branch) near Riverton, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 10	F. H. Brundage	232	417	1.39	4.81	578
July 1	Hoyt and Hall	235	425	1.13	4.71	[a] 480
September 27	E. C. Murphy	234	240	.39	3.95	93
October 19	do	235	292	.45	4.11	130

[a] Average of two measurements.

Mean daily gage height, in feet, of Shenandoah River (North Branch) near Riverton, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 4.20	.....	.....	4.88	5.85	5.65	4.72	4.30	4.10	4.05	4.00	4.02
2	[a] 4.20	.....	.....	5.00	5.70	5.05	4.50	4.45	4.05	4.00	4.00	4.05
3	[a] 4.20	.....	.....	4.98	5.40	4.85	4.38	4.40	4.15	3.95	4.05	4.10
4	[a] 4.20	.....	.....	4.88	5.10	4.80	4.30	4.50	4.15	4.00	4.05	4.10
5	[a] 4.20	.....	[b] 4.70	4.80	5.05	4.85	4.35	4.50	4.10	4.10	4.00	4.10
6	[a] 4.20	.....	4.65	4.72	5.00	6.05	4.35	4.80	4.05	4.10	4.05	4.20
7	[a] 4.20	.....	4.70	4.72	4.90	6.70	4.32	4.50	4.05	4.00	4.05	4.20
8	[a] 4.20	.....	6.20	4.70	4.90	5.30	4.35	4.50	4.10	4.05	4.00	4.10
9	[a] 4.20	.....	6.20	4.75	4.90	4.95	4.40	4.45	4.05	4.00	4.00	4.10
10	[a] 4.20	.....	5.60	5.10	5.00	4.80	6.15	4.38	4.10	4.00	4.10	4.15
11	[a] 4.20	.....	5.15	5.38	4.95	4.72	6.82	4.40	4.10	4.00	4.10	4.20
12	[a] 4.20	.....	5.00	5.15	4.90	4.60	6.00	4.35	4.10	4.10	4.05	[d] 4.50
13	[a] 4.20	.....	4.90	5.00	4.90	4.50	5.75	4.35	4.05	4.00	4.10	4.50
14	[a] 4.20	.....	4.80	4.90	4.80	4.50	5.10	4.30	4.20	4.05	4.10	4.50
15	[a] 4.20	.....	4.78	4.80	4.75	4.40	4.85	4.20	4.20	4.00	4.05	4.50
16	[a] 4.20	.....	4.70	4.72	4.80	4.45	4.70	4.30	4.15	4.05	4.10	4.50
17	[a] 4.20	.....	4.70	4.65	4.70	4.45	4.60	4.20	4.15	4.05	4.10	4.50
18	[a] 4.20	.....	4.68	4.55	4.70	4.42	4.55	4.22	4.10	4.05	3.98	4.50
19	[a] 4.20	.....	4.60	4.58	4.78	4.50	4.50	4.20	4.10	4.00	4.00	4.50
20	[a] 4.20	.....	4.52	4.50	6.45	4.75	4.70	4.22	4.05	4.05	4.00	4.50
21	[a] 4.20	.....	4.55	4.45	5.70	5.25	4.55	4.20	4.25	4.05	4.00	4.50
22	[a] 4.20	.....	4.52	4.48	5.35	5.30	4.40	4.20	4.10	4.00	4.10	4.50
23	[c] 4.20	.....	4.65	4.40	5.15	4.85	4.38	4.30	4.05	4.10	4.10	4.50
24	.....	.....	4.75	4.40	4.95	4.62	4.35	4.35	4.10	4.10	4.10	4.50
25	.....	.....	4.80	4.38	4.78	4.45	4.50	4.20	4.00	4.00	4.02	4.50
26	.....	.....	4.80	4.50	5.15	4.40	4.50	4.25	4.00	4.10	4.00	4.55
27	.....	.....	4.80	4.60	4.95	4.35	4.40	4.20	3.98	4.05	4.05	4.60
28	.....	.....	4.78	6.00	4.80	4.40	4.40	4.20	4.05	4.05	4.00	4.65
29	.....	.....	4.70	7.05	4.70	4.38	4.65	4.10	4.05	4.10	4.05	4.46
30	.....	.....	4.70	6.40	4.60	4.75	4.55	4.10	4.10	4.02	4.10	4.45
31	.....	.....	4.78	.....	4.80	.....	4.45	4.15	.....	4.05	.....	4.35

[a] Frozen up.
[b] The gage was put back March 5, just as it was before, and read from that date.
[c] Ice breaking up.
[d] River frozen Dec. 12 to 25.

MONOCACY RIVER NEAR FREDERICK, MD.

This station was established August 4, 1896, by E. G. Paul, and is located at the county bridge on the toll road leading from Frederick to Mount Pleasant, Md. It is 4 miles northeast of Frederick, about 2,000 feet above the mouth of Israel Creek, and 3,000 feet below the mouth of Tuscarora Creek. The original wire gage has been replaced by a standard chain gage, which is located in the middle of the first span from the right bank and is attached to the bridge floor on the lower side of the bridge. The length of the chain from the end of the weight to the marker is 35.20 feet. The bench mark is a hole drilled in the top of a coping stone on the lower wing of the right abutment, about 100 feet back from the initial point for soundings. Its elevation is 29.17 feet above gage datum. Discharge measurements are made

he two-span iron highway bridge. The initial point for sound- a cross cut in the face of the parapet wall on the lower wing of ght abutment. The channel is straight for 300 feet above and t below the bridge. The bridge has a total span of 310 feet. annel at this point is divided by a small, low island, which serves undation for the middle pier of the bridge. The right channel sured from the lower and the left from the upper side of the , as these are better than a continuous section on either side of idge. The pier and island obstruct the flow to some extent, g dead water for 20 feet to the right of the pier at low water dies at high water. Both banks are low, liable to overflow, and d with a fringe of trees, but all water passes beneath the bridge. ed is composed of gravel and cobblestones, except near the where it is composed of silt and is subject to change. The gage twice each day by E. L. Derr.

observations of this station during 1904 have been made under ection of N. C. Grover, district hydrographer.

Discharge measurements of Monocacy River near Frederick, Md., in 1904.

te.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
.....	Hoyt and Grover	172	384	1.24	5.18	475
er 26 ..	N. C. Grover	195	184	0.54	3.71	100
20 [a] ...	E. C. Murphy	56	55	1.78	3.67	98

[a] Made above bridge by wading.

daily gage height, in feet, of Monocacy River near Frederick, Md., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	4.6	4.9	8.1	5.8	4.9	7.4	4.4	4.2	3.8	3.7	3.7	3.7
.....	4.9	4.9	7.5	7.2	4.7	6.4	4.3	4.9	3.8	3.7	3.7	3.7
.....	4.8	5.4	6.1	6.4	4.7	5.9	4.2	4.7	3.8	3.6	3.7	3.7
.....	[a] 5.5	4.9	6.2	5.4	4.7	5.3	4.2	4.5	3.8	3.6	3.7	3.7
.....	[a] 5.1	4.6	5.9	5.4	4.7	7.3	4.1	4.3	3.8	3.5	3.7	3.7
.....	[a] 4.9	4.6	5.9	5.4	4.7	6.9	4.1	4.0	3.9	3.5	3.7	3.7
.....	[a] 4.7	8.2	17.0	5.4	4.7	6.8	4.4	4.0	3.9	3.5	3.7	3.7
.....	[a] 4.6	[b] 14.2	[c] 17.2	5.6	4.9	5.6	6.1	4.2	3.9	3.5	3.7	3.7
.....	[a] 4.6	6.4	8.1	7.7	4.9	5.4	7.1	4.5	3.9	3.5	3.7	3.7
.....	[a] 4.6	6.1	6.5	7.2	5.7	5.1	8.1	4.5	4.9	3.5	3.9	3.9
.....	[a] 4.6	5.9	6.6	6.3	5.4	5.3	7.2	[d] 12.6	5.2	3.5	3.8	4.0
.....	[a] 4.6	5.4	6.9	5.9	4.7	5.1	6.1	5.6	4.9	3.6	3.8	4.0
.....	[a] 4.6	5.1	6.2	5.6	4.7	4.9	7.4	4.6	4.8	5.7	3.9	4.0
.....	[a] 4.6	[a] 4.9	5.9	5.3	4.7	4.7	6.4	4.2	4.8	5.2	4.2	4.0
.....	[a] 4.6	[a] 4.9	5.7	5.1	5.0	4.5	5.2	4.2	4.7	4.6	4.1	4.0
.....	[a] 4.6	[a] 4.9	5.6	5.1	4.9	4.5	4.2	4.1	4.7	3.8	4.0	4.0
.....	[a] 4.5	[a] 4.9	5.6	5.0	4.8	4.5	4.1	4.1	4.6	3.7	4.0	4.0

en at gage.
to thawing.

[c] Thaw. Maximum gage height, 22.9, due to rain.
[d] Rain.

Mean daily gage height, in feet, of Monocacy River near Frederick, Md., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
18	[a] 4.5	[a] 4.9	5.5	4.9	4.8	4.5	4.1	4.0	4.6	3.6	3.9	4.0
19	[a] 4.5	[a] 4.9	5.5	4.8	5.2	4.5	4.1	4.0	4.6	3.6	3.9	4.0
20	[a] 4.5	[a] 4.9	5.8	4.8	5.1	[b] 9.7	4.0	4.2	5.6	3.6	3.9	4.0
21	[a] 4.5	[a] 4.9	6.1	4.7	4.9	7.3	4.0	4.7	5.2	3.7	3.8	4.0
22	[a] 4.5	[c] 13.8	6.5	4.6	4.7	5.9	4.0	4.7	4.9	4.8	3.8	4.0
23	[c] 19.9	12.2	6.8	4.6	4.6	4.8	4.0	4.6	4.6	4.4	3.8	4.0
24	11.5	9.0	6.1	4.6	4.5	4.5	5.1	4.5	4.4	4.1	3.8	4.2
25	6.1	6.8	5.9	4.6	4.4	4.3	5.1	4.2	3.9	3.9	3.8	4.4
26	5.9	5.1	5.7	4.7	4.4	4.2	5.1	4.2	3.7	3.8	3.8	5.1
27	4.6	4.9	5.6	4.9	4.4	4.1	5.1	4.1	3.9	3.8	3.8	[b] 6.5
28	4.6	4.8	5.4	5.3	4.4	4.1	5.0	3.9	4.1	3.7	3.7	9.2
29	5.5	4.8	5.2	5.2	4.3	4.2	4.9	3.8	3.9	3.7	3.7	8.9
30	6.1	.....	5.1	5.1	4.3	4.2	4.4	3.8	3.7	3.7	3.7	7.5
31	5.9	.....	5.4	.....	4.5	.....	4.2	3.8	.....	3.7	.....	5.5

[a] Frozen at gage. [b] Rain. [c] Ice broke.

Rating table for Monocacy River near Frederick, Md., from January 1, 1902, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.50	73	4.90	460	6.60	1,420	14.00	7,340
3.60	86	5.00	500	6.80	1,580	15.00	8,140
3.70	101	5.10	540	7.00	1,740	16.00	8,940
3.80	118	5.20	580	7.20	1,900	17.00	9,740
3.90	137	5.30	630	7.40	2,060	18.00	10,540
4.00	158	5.40	680	7.60	2,220	19.00	11,340
4.10	181	5.50	730	7.80	2,380	20.00	12,140
4.20	207	5.60	780	8.00	2,540	21.00	12,940
4.30	235	5.70	835	8.50	2,940	22.00	13,740
4.40	268	5.80	890	9.00	3,340	23.00	14,540
4.50	303	5.90	945	10.00	4,140	24.00	15,340
4.60	340	6.00	1,000	11.00	4,940	25.00	16,140
4.70	380	6.20	1,120	12.00	5,740		
4.80	420	6.40	1,260	13.00	6,540		

The above table is applicable only for open-channel conditions. It is based upon 26 discharge measurements made during 1896–1904. It is well defined between gage heights 3.65 feet and 10 feet. The table has been extended beyond these limits. Above gage height 6.50 feet the rating curve is a tangent, the difference being 80 per tenth.

Estimated monthly discharge of Monocacy River near Frederick, Md., for 1904.

[Drainage area, 665 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	12,060	305	1,001	1.51	1.74
February	7,460	340	1,409	2.12	2.29
March	9,900	540	1,690	2.54	2.93
April	2,300	340	750	1.13	1.26
May	835	235	405	.609	.702
June	3,900	181	814	1.22	1.36
July	2,620	158	610	.917	1.06
August	6,220	118	447	.672	.775
September	780	101	283	.426	.475
October	835	73	160	.241	.278
November	207	101	122	.183	.204
December	3,500	101	487	.732	.844
The year	12,060	73	682	1.02	13.918

JAMES RIVER DRAINAGE BASIN.

The headwaters of James River lie in the high mountains in the extreme western part of Virginia. It is formed by the confluence of Jackson and Cowpasture rivers in the extreme northern part of Botetourt County, Va., thence it flows easterly across the State and empties into Chesapeake Bay through Hampton Roads.

The river with all of its tributaries lies wholly in Virginia. Its total length is about 335 miles and its total drainage area about 9,700 square miles. The basin is varied in character, changing from the mountainous section in the upper part to low, flat, and often swampy areas as tide water is approached. Jackson and Cowpasture rivers flow from narrow valleys between steep hills over beds of sand and gravel with rock ledges in places, and are bordered with fertile bottom lands. In this portion of the basin the water collects quickly, causing rapid rises in the river below. The James, cutting as it does through the ridges of the mountains, flows alternately across fertile valleys with a gentle current and through breaks in the ridges with rocky and precipitous banks, the fall in these localities being often considerable. It crosses the fall line at Richmond.

Near Cliftonforge and again near Balcony Falls the James flows through ridges of the Alleghenies, with sharp falls over beds of solid rock. At other points similar though less pronounced falls and rapids

occur, as the river cuts through the lesser foothills. Between these mountainous or hilly sections the flow is through broad and fertile valleys over sand and gravelly beds with gentle slope. The fall line is finally crossed at Richmond. A considerable number of dams have been built in the river, generally for diverting water into the old James and Kanawha canal, which followed the river from Richmond to Buchanan, and was at one time utilized throughout that entire distance. The use of this canal has now been abandoned, however, and its right of way is owned and for considerable distances occupied by the Chesapeake and Ohio Railroad. The use of the dams was abandoned with the canal, and in many instances they have not been utilized for power purposes although in good repair.

The principal utilized power on the river is at Richmond. Fluctuations in stage are great. The record of gage height at Cartersville, Va., which extends over a period of five years, shows a range in gage height of nearly 25 feet. The estimated discharge has varied between 75,000 and 500 cubic feet per second.

Prof. D. C. Humphrey made a survey of the river from Richmond to Cliftonforge in 1897, and the profile developed by him was published in Part IV of the Nineteenth Annual Report of the United States Geological Survey, pages 162–173.

Gages were established on James River in 1893 by F. B. Isaacs, engineer for water power of the Chesapeake and Ohio Railway Company, at Ninemile Locks, Columbia, Scottsville, Lynchburg, Balcony Falls, Buchanan, Eagle Mountain, and Cliftonforge. Records of heights of water at these points were made twice daily from 1893 to 1897, and freshet reports were obtained for these years. The gages were not referred to any fixed datum, but the zero of each gage was set at what was considered ordinary low water in the river. During the latter part of 1899 records were resumed, excepting at Scottsville, Balcony Falls, and Eagle Mountain, where the gages have been abandoned.

At Boshers dam, 9 miles above Richmond, is a gage where the height of water is recorded twice daily, showing the supposed head on the crest of dam. This crest, however, is so irregular that the coefficient of discharge has not been ascertained. Another complication exists in the fact that water is deflected into a canal, the quantity not being known.

The United States Weather Bureau maintains river stations in this basin as follows:

James at Lynchburg, Va.
James at Columbia, Va.
James at Richmond, Va.

During 1904 the United States Geological Survey has maintained ging stations in this basin as follows:

James at Buchanan, Va.
James at Holcomb Rock, Va.
James at Cartersville, Va.
North (of James) at Glasgow, Va.
Appomattox at Mattoax, Va.

JAMES RIVER AT BUCHANAN, VA.

This station was established August 18, 1895, by C. C. Babb. It is ated at the iron highway bridge near the Chesapeake and Ohio Rail- y station, and one-half mile from the Norfolk and Western Railway tion. It is about 20 miles above the mouth of North River and one- lf mile above the mouth of Purgatory Creek. The United States eather Bureau maintained a gage at this point for about two years fore measurements were made by the Geological Survey. On April 1897, the datum of the original wire gage was lowered 2 feet to oid negative readings. On November 21, 1903, the wire gage was placed by a standard chain gage installed by W. C. Sawyer. It is cated on the upstream side of the bridge near the center of the left an. The length of the chain from the end of the weight to the arker is 35 feet. Bench mark No. 1 is the top of the upper end of e third floor beam from the left bank. Its elevation is 29.87 feet bove gage datum. Bench mark No. 2 is the top of a stone post nder the southwest corner of the porch of the Chesapeake and hio Railway station. Its elevation is 24.50 feet above gage datum. ench mark No. 3 is a copper bolt in a ledge of rock on the left bank 00 feet above the station. Its elevation is 16.14 feet above gage atum. This bench mark was established November 21, 1903, at which me the old bench mark on this ledge could not be found. Bench ark No. 4 is the top of the upper end of the seventh floor beam from e left bank. Its elevation is 29.92 feet above gage datum. Dis- arge measurements are made from the lower side of the two-span on highway bridge, which has a total span of 350 feet. The initial oint for soundings is the end of pin on the lower side of bridge at e left bank. The channel is straight for 800 feet above and for out the same distance below the station. The current has a moderate locity and is broken by the middle pier of the two-span bridge. oth banks are high, not liable to overflow, and without trees. The d of the stream is rocky and free from vegetation. The gage is ad twice each day by U. H. Hyde.

The observations at this station during 1904 have been made under e direction of N. C. Grover, district hydrographer.

Discharge measurements of James River at Buchanan, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 17	R. H. Bolster	320	1,119	1.34	2.98	1,498
August 8	N. C. Grover	323	860	.90	2.32	775
September 17	R. H. Bolster	284	707	.56	1.81	393
September 30	do	284	687	.53	1.74	[a] 364
October 19	do	284	676	.46	1.70	[a] 314

[a] Slight change in bed.

Mean daily gage height, in feet, of James River at Buchanan, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	2.71	4.74	3.39	4.72	4.89	3.10	2.42	1.82	1.72	1.75	1.80
2	2.36	2.85	5.44	3.70	4.29	8.02	2.85	2.28	1.80	1.73	1.75	1.80
3	2.28	2.73	4.76	3.71	3.89	8.74	2.71	2.18	1.90	1.73	1.75	1.80
4	2.38	2.42	4.12	3.57	3.79	6.39	2.55	2.10	1.90	1.72	1.75	1.80
5	2.47	2.42	3.32	3.43	3.59	5.38	2.47	2.40	1.90	1.70	1.77	1.80
6	2.43	2.36	3.96	3.27	3.46	4.56	2.45	2.37	1.88	1.70	1.78	1.82
7	2.38	2.62	8.27	3.19	3.39	4.12	2.37	2.29	1.85	1.70	1.77	1.85
8	2.38	4.19	7.20	3.25	3.54	4.04	2.46	2.39	1.80	1.70	1.75	1.85
9	2.33	4.39	6.26	4.47	3.69	3.62	2.31	2.20	1.81	1.70	1.75	1.90
10	2.30	3.69	5.11	4.27	3.59	3.42	2.26	2.20	1.84	1.70	1.75	1.92
11	2.30	3.32	4.48	3.95	3.49	3.34	2.25	2.63	1.85	1.70	1.71	1.93
12	2.28	3.02	4.08	3.77	3.32	3.23	2.49	2.44	1.91	1.70	1.71	1.92
13	2.22	2.82	4.10	3.57	3.16	3.09	2.34	2.25	1.90	1.70	1.75	1.90
14	2.18	2.65	3.86	3.47	3.14	2.93	2.24	2.16	1.85	1.70	1.85	1.90
15	2.08	2.55	3.78	3.33	3.22	2.76	2.19	2.10	1.82	1.70	1.95	1.88
16	1.98	2.47	3.76	3.25	3.34	2.83	2.10	2.00	1.80	1.70	1.90	1.87
17	1.98	2.29	3.54	3.17	3.24	3.00	2.08	2.25	1.80	1.70	1.88	1.85
18	1.98	2.28	3.38	3.05	4.86	3.15	2.01	2.10	1.80	1.70	1.85	1.85
19	1.98	2.55	3.32	2.95	10.12	3.04	2.00	2.20	1.80	1.70	1.83	1.85
20	2.03	2.69	3.22	2.89	7.19	3.17	1.90	2.10	1.80	1.70	1.83	1.85
21	2.13	2.52	3.12	2.79	5.72	3.48	1.90	2.10	1.80	1.75	1.80	1.83
22	2.45	3.22	3.04	2.75	4.86	3.32	1.90	2.10	1.80	1.75	1.80	1.82
23	5.18	5.92	3.32	2.70	4.38	3.01	2.04	2.10	1.78	1.75	1.87	1.82
24	4.78	4.65	4.56	2.65	4.04	2.76	2.19	2.00	1.78	1.75	1.85	1.80
25	3.73	4.32	4.24	2.63	4.04	2.62	2.22	1.97	1.77	1.75	1.83	1.92
26	3.36	3.39	4.04	2.94	4.10	2.54	2.22	1.95	1.77	1.75	1.83	2.12
27	3.10	3.55	3.94	6.40	4.34	2.48	2.20	1.90	1.75	1.75	1.83	2.29
28	2.70	3.33	3.74	8.07	4.32	2.74	2.21	1.90	1.75	1.75	1.83	2.35
29	2.40	3.61	3.57	6.30	3.78	3.42	2.20	1.85	1.75	1.75	1.80	2.42
30	2.39	.....	3.42	5.35	3.54	3.22	2.15	1.85	1.75	1.75	1.80	2.29
31	2.56	.....	3.28	.....	3.64	.....	2.07	1.82	.....	1.75	.....	2.22

Rating table for James River at Buchanan, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.70	330	2.40	861	3.40	2,100	4.40	3,840
1.75	356	2.50	960	3.50	2,250	4.50	4,030
1.80	385	2.60	1,060	3.60	2,410	4.60	4,220
1.85	416	2.70	1,170	3.70	2,570	4.70	4,420
1.90	449	2.80	1,285	3.80	2,740	4.80	4,620
1.95	484	2.90	1,405	3.90	2,910	4.90	4,825
2.00	520	3.00	1,535	4.00	3,090	5.00	5,035
2.10	598	3.10	1,670	4.10	3,270		
2.20	681	3.20	1,810	4.20	3,460		
2.30	768	3.30	1,950	4.30	3,650		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1904 up to gage height 3 feet. Above 3 feet the curve is based upon three measurements made in 1901 and 1903. It is well defined between gage heights 1.70 and 4 feet.

Measurements above 5 feet gage height are estimated.

Estimated monthly discharge of James River at Buchanan, Va., for 1904.

[Drainage area, 2,058 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	5,413	506	1,164	0.566	0.653
February	7,110	750	1,916	.931	1.00
March	14,010	1,587	3,749	1.82	2.10
April	13,330	1,093	2,937	1.43	1.60
May	20,880	1,726	3,771	1.83	2.11
June	15,640	940	3,143	1.53	1.71
July	1,670	449	762	.370	.427
August	1,093	397	647	.314	.362
September	456	356	397	.193	.215
October	356	330	341	.166	.191
November	484	335	388	.189	.211
December	881	385	484	.235	.271
The year	20,880	330	1,642	.798	10.850

JAMES RIVER AT HOLCOMB ROCK, VA.

This station was established by the Willson Aluminum Company, of Holcomb Rock, Va., in 1899, in connection with measurements to determine the horsepower available at that point. During 1899 the records were fragmentary, but at the commencement of 1900 daily records were taken, which have been furnished to the Geological Survey through the courtesy of George O. Seward, general manager of the company. The gage consists of a copper float 8 by 8 by 8 inches, with a vertical rod 1½ inches square attached to it. The rod, which extends up through the powerhouse floor, is graduated to tenths of a foot. The copper float is inclosed in a 12-inch by 12-inch by 12-foot box, which rests solidly on the bottom of the river. The box is perforated, so that the water in it will always stand at the same level as the water in the river, while the float, being inclosed, is not in danger of being broken by floating timber. The fluctuations of the river are read directly from the rod, which moves up or down with the float as it responds to the variations in the height of the river.

Mean daily gage height, in feet, of James River at Holcomb Rock, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.75	.....	2.30	4.00	3.80	2.01	1.25	0.95	0.75	0.90	0.70
2	1.40	1.70	.....	2.60	3.70	7.25	1.80	1.40	.95	.25	.70	.75
3	1.10	1.55	.....	2.50	3.15	8.80	1.70	1.30	1.00	1.15	.65	.80
4	1.20	1.50	.....	2.50	2.80	6.70	1.65	1.30	.85	.80	.75	1.05
5	1.65	1.50	.....	2.40	2.65	5.00	1.60	1.30	1.00	.80	.80	1.10
6	1.55	1.55	3.05	2.25	2.50	6.35	1.65	1.30	1.00	.40	.20	1.10
7	1.40	2.25	4.50	2.20	2.35	3.25	1.56	1.30	.90	.85	.95	1.25
8	1.40	3.05	8.95	2.25	2.65	3.25	1.40	1.60	.90	.75	.75	1.20
9	1.40	3.60	6.85	2.55	2.85	2.75	1.40	1.30	.80	.25	.70	1.20
10	1.35	3.05	4.95	3.25	3.15	2.55	1.40	1.40	.90	.75	.75	1.00
11	1.40	2.40	4.05	3.15	2.90	2.35	1.45	1.90	.65	.85	.70	.65
12	1.35	2.10	3.50	2.85	2.65	2.20	1.60	1.90	.95	.85	.80	1.25
13	1.30	2.00	3.30	2.65	2.40	2.10	1.50	1.50	.95	.75	.20	.90
14	1.25	1.85	3.10	2.45	2.30	1.95	1.45	1.20	.95	.75	1.15	.75
15	1.10	1.60	2.85	2.25	2.30	1.75	1.25	1.40	1.00	.80	.85	.75
16	1.20	1.80	2.80	2.25	2.35	1.85	1.30	1.45	1.00	.00	.90	.85
17	.85	1.60	2.65	2.05	2.30	2.10	1.25	1.30	.95	.45	.90	.80
18	1.30	1.45	2.50	2.10	2.50	1.85	1.20	1.50	.75	.70	.80	.80
19	1.15	1.60	2.35	2.05	10.00	1.95	1.00	.90	.90	.60	.80	.80
20	1.15	1.70	2.15	1.95	8.05	1.85	1.20	1.35	.90	.65	.20	.65
21	1.20	1.60	2.20	1.80	5.50	2.60	1.10	1.05	.90	.85	.95	.85
22	1.45	3.20	2.15	1.70	4.30	2.50	1.20	1.30	.80	.95	.75	.90
23	3.75	5.50	2.10	1.70	3.60	2.10	1.30	1.30	.80	1.00	.80	.90
24	3.85	4.35	2.55	1.70	3.10	1.90	1.20	1.15	.80	.70	.80	.90
25	3.20	3.55	3.45	1.60	3.05	1.80	1.40	1.15	.45	.75	.90	.95
26	2.50	3.15	3.10	1.60	3.15	1.60	1.40	1.05	1.10	.70	.80	.95
27	2.20	2.60	2.85	2.65	3.30	1.60	1.25	1.00	.85	.75	.85	.85
28	1.90	.....	2.75	8.75	3.30	2.05	1.30	1.00	.80	.70	.90	1.45
29	1.75	.....	2.55	5.90	2.80	2.10	1.55	1.10	.70	.80	.85	1.35
30	1.75	.....	2.44	4.85	2.50	2.15	1.40	.90	.70	.05	.75	1.30
31	1.65	.....	2.30	.....	2.40	.....	1.00	1.00	.....	.75	.....	1.25

JAMES RIVER AT CARTERSVILLE, VA.

This gaging station was established January 1, 1899, by D. C. umphreys, and is located at the highway bridge crossing the James etween Pemberton and Cartersville, one-half mile from the railroad ation at Pemberton and 50 miles above Richmond, Va. The original ire gage was attached to the bridge and referred to a bench mark, the op of the lower end of the fourth floor beam from the right bank, which 32.04 feet above the zero of the gage. This gage was verified June 3, 1899. The original wire gage was replaced by a standard chain age installed July 24, 1903, by B. S. Drane. The length of the hain from the end of the weight to the marker is 37.98 feet. Bench ark No. 1 is a standard copper plug set in the capstone of the right butment at its lower end. It is inclosed by a ring of white paint nd is marked by the letters "B.M.U.S.G.S.Hydro." Its elevation s 31.74 feet above gage datum. Bench mark No. 2 is a spot of white paint on the inner eyebar of the lower chord of the bridge, under the pulley end of the gage box. Its elevation is 32.91 feet above gage datum. To provide for readings over 10 feet, two additional markers, respectively 10 and 20 feet below the first, have been placed. The gage is attached to the timbers of the second span from the right bank on the downstream side, at the same height as the hand rail. Discharge measurements are made from the lower side of the bridge to which the gage is attached. The initial point for soundings is the right end of the downstream hand rail. Distances are marked with white paint on the rail. The channel is straight for one-third mile above the station and for 1 mile below. Both banks are high and will overflow only at extreme flood stages. The bed of the stream is composed of rocks and sand and is somewhat shifting. The gage is read once each day by B. W. Palmore, the postmaster.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of James River at Cartersville, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 23	R. H. Bolster	688	2,546	1.96	2.84	4,994
September 13	do	639	1,202	1.08	.75	1,301
October 3	do	638	1,169	.96	.70	1,117
October 22	J. C. Hoyt	638	1,265	1.11	.85	1,405

Mean daily gage height, in feet, of James River at Cartersville, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	D
1	1.60	2.10	3.38	3.30	5.90	3.85	2.55	1.45	0.81	0.80	0.65	(
2	1.68	2.00	3.30	3.10	5.00	5.20	2.52	1.72	1.00	.75	.75	
3	1.50	1.90	4.85	3.10	4.32	7.52	2.10	3.10	.90	.70	.75	
4	1.38	1.85	4.85	3.30	3.77	10.00	1.85	2.52	.85	.55	.72	
5	1.35	1.80	4.30	3.28	3.48	7.40	1.70	1.58	.80	.50	.80	
6	1.35	1.88	3.90	3.00	3.22	5.98	1.62	3.37	.70	.55	.72	
7	2.25	3.32	6.08	3.10	3.10	4.92	1.48	2.00	.85	.55	.70	
8	2.55	3.80	13.00	3.05	6.30	4.40	1.85	2.35	.85	.70	.70	
9	1.90	3.50	11.10	3.10	4.92	4.03	1.90	1.70	.80	.65	.70	
10	1.55	4.80	9.18	3.65	5.12	3.60	2.00	1.80	.98	.55	.75	
11	1.45	4.52	6.65	4.55	4.80	3.30	2.55	1.80	1.10	.52	.80	
12	1.47	3.25	5.50	4.10	4.20	2.85	1.52	1.90	.95	.50	.78	
13	1.62	2.90	4.70	3.78	3.75	2.62	1.40	2.12	.78	.50	1.00	
14	1.55	2.75	4.60	3.40	3.42	2.45	1.60	2.00	1.25	.50	1.45	
15	1.50	2.52	4.40	3.20	3.25	2.30	1.48	1.90	3.80	.50	1.32	
16	1.45	2.22	4.00	3.00	3.12	2.18	1.30	1.77	2.43	.68	1.10	
17	1.35	2.20	3.70	2.75	3.02	2.15	1.38	1.40	1.80	.68	1.00	
18	1.40	1.80	3.58	2.58	3.43	2.22	1.40	2.00	.98	.65	.92	
19	1.25	1.90	3.50	2.55	5.13	2.18	1.30	1.95	.98	.55	.95	
20	1.35	2.00	3.20	2.40	10.55	2.15	1.25	1.90	.88	.60	.93	
21	1.45	2.25	3.15	2.30	9.15	2.32	1.10	1.45	.82	.60	.90	a
22	1.68	4.60	3.00	2.20	6.15	2.40	1.00	1.23	.95	.82	.85	a
23	2.42	6.22	2.90	2.10	5.32	2.85	1.30	1.21	.90	.82	.88	a
24	3.00	6.29	2.85	2.08	4.50	2.52	2.08	1.20	.88	.78	.95	
25	5.60	6.15	2.85	2.05	3.98	2.18	2.00	1.28	.82	.75	.90	
26	4.02	4.63	4.30	2.00	3.55	1.88	1.55	1.19	.80	.78	.90	
27	3.48	4.12	4.00	3.00	3.52	1.80	1.62	1.00	.75	.70	.85	
28	3.25	3.95	3.98	6.00	3.50	1.65	2.05	1.00	.68	.62	.85	
29	2.85	3.50	3.65	9.60	3.60	2.00	1.90	.98	.82	.62	.80	
30	1.90	.....	3.30	7.42	3.45	2.35	1.95	.80	.85	.70	.75	
31	2.10	.....	4.00	.....	3.02	.....	1.60	.65	.....	.75	.....	

a River frozen.

ting table for James River at Cartersville, Va., from January 1, 1897, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.50	755	3.20	5,890	5.90	12,170	11.00	28,400
.60	935	3.30	6,100	6.00	12,430	11.20	29,120
.70	1,115	3.40	6,310	6.20	12,970	11.40	29,840
.80	1,295	3.50	6,520	6.40	13,520	11.60	30,560
.90	1,475	3.60	6,740	6.60	14,080	11.80	31,280
1.00	1,660	3.70	6,960	6.80	14,650	12.00	32,000
1.10	1,845	3.80	7,180	7.00	15,230	12.50	33,850
1.20	2,030	3.90	7,400	7.20	15,810	13.00	35,700
1.30	2,215	4.00	7,620	7.40	16,410	13.50	37,600
1.40	2,400	4.10	7,840	7.60	17,010	14.00	39,500
1.50	2,585	4.20	8,060	7.80	17,630	14.50	41,450
1.60	2,770	4.30	8,290	8.00	18,250	15.00	43,400
1.70	2,955	4.40	8,520	8.20	18,890	16.00	47,400
1.80	3,140	4.50	8,750	8.40	19,530	17.00	51,400
1.90	3,330	4.60	8,980	8.60	20,180	18.00	55,400
2.00	3,520	4.70	9,210	8.80	20,840	19.00	59,400
2.10	3,710	4.80	9,440	9.00	21,500	20.00	63,400
2.20	3,900	4.90	9,680	9.20	22,180	21.00	67,400
2.30	4,095	5.00	9,920	9.40	22,860	22.00	71,400
2.40	4,290	5.10	10,160	9.60	23,540	23.00	75,400
2.50	4,485	5.20	10,400	9.80	24,220	24.00	79,400
2.60	4,680	5.30	10,640	10.00	24,900	25.00	83,400
2.70	4,880	5.40	10,890	10.20	25,600	26.00	87,400
2.80	5,080	5.50	11,140	10.40	26,300	27.00	91,400
2.90	5,280	5.60	11,390	10.60	27,000	28.00	95,400
3.00	5,480	5.70	11,650	10.80	27,700	29.00	99,400
3.10	5,680	5.80	11,910				

The above table is applicable only for open-channel conditions. It is based upon 23 discharge measurements made during 1897 to 1904, inclusive. It is well defined between gage heights 0.40 feet and 5 feet. The table has been extended beyond these limits. Above gage height 15 feet the rating curve is a tangent, the difference being 400 per tenth.

Estimated monthly discharge of James River at Cartersville, Va., for 1904.

[Drainage area, 6,230 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	11,390	2,123	3,662	0.587	0.676
February	13,240	3,140	6,200	.995	1.070
March	35,700	5,180	9,786	1.57	1.81
April	23,540	3,520	6,645	1.07	1.19
May	26,825	5,480	9,043	1.45	1.67
June	24,900	2,863	6,785	1.09	1.22
July	4,583	1,660	2,975	.477	.550
August	6,205	1,025	2,918	.468	.540
September	7,180	1,079	1,692	.271	.302
October	1,331	755	1,012	.162	.187
November	2,493	1,025	1,425	.229	.256
December	4,485	1,385	2,755	.442	.510
The year	35,700	755	4,575	.734	9.980

NORTH (OF JAMES) RIVER NEAR GLASGOW, VA.

This river rises on the western slope of the Shenandoah Mountains and flows in a southeasterly direction across the valley between the Shenandoah and Blue Ridge ranges, emptying into James River about 17 miles south of Lexington, Va. Its drainage basin is largely under cultivation, except in the upper part, where it is mountainous and covered with forest growth. This station was established August 21, 1895, by C. C. Babb, assisted by D. C. Humphreys. It is located at the county bridge, three-fourths of a mile from the post-office at Glasgow, Va., and 1 mile above the mouth of North River. The original gage was of the wire type. On July 22, 1903, a vertical rod gage was placed in position. This consists of a 2 by 6 inch rod, nailed to a 3 by 6 inch oak timber, which is sunk to a firm foundation and securely nailed and braced to an overhanging tree on the right bank below the bridge. This gage was established on the same datum as the original wire gage and was read from the bridge. On November 24, 1903, a standard chain gage was established on the lower side of the bridge in the right span. Its datum is the same as that of the wire gage and rod gage, which it replaces. The length of the chain from the marker to the end of the weight is 28 feet. Bench mark No. 1 is a standard copper plug set in the downstream end of the capstone of the right abutment. It is inclosed in a ring of white paint and is marked by the

'B. M. U. S. G. S. Hydro." Its elevation is 23.90 feet above
:um. Bench mark No. 2 is the upper surface of the upper
'er the pulley of the chain gage. Its elevation is 32.28 feet
ıge datum. Discharge measurements are made from the lower
he bridge to which the gage is attached. The initial point for
gs is the center of the end pin of the downstream truss on the
k. Originally measurements were made from the sidewalk on
ream side of the bridge, at which point there is a good section.
ng with 1902, measurements were made from the lower side of
ge on account of the removal of the sidewalk. The section on
:r side of the bridge is not as favorable for accurate measure-
ı account of sunken logs and on account of the bridge piers.
nnel is straight for 600 feet above and below the station and
dth of 240 feet, broken by two iron piers. Both banks are
inged with trees, and not liable to overflow, except at very
ter. The bed of the stream is rocky near the right bank and
ɔsed of rocks and mud near the left. The gage is read once
' by B. G. Baldwin.

bservations at this station during 1904 have been made under
:tion of N. C. Grover, district hydrographer.

Discharge measurements of North (of James) River near Glasgow, Va.

	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
.....	F. H. Brundage.....	206	648	0.81	1.13	523
r 19..	R. H. Bolster.....	197	504	.34	.45	170
r 30..	.....do	197	512	.35	.49	179
9.....	.....do	197	506	.31	.46	157

y gage height, in feet, of North (of James) River near Glasgow, Va., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
....	0.90	1.15	1.85	1.55	1.95	2.95	1.00	0.70	0.40	0.50	0.40	0.60
....	.90	1.10	2.05	1.55	1.70	2.75	1.00	.65	.45	.50	.40	.60
....	.90	1.10	1.95	1.45	1.45	3.45	1.85	.70	.50	.35	.40	.60
....	1.20	.90	1.75	1.45	1.35	2.95	1.80	.90	.50	.45	.40	.60
....	1.00	1.00	1.65	1.40	1.30	2.45	1.05	.85	.50	.45	.40	.60
....	.90	1.00	1.65	1.40	1.30	1.95	.90	2.00	.50	.45	.45	.60
....	.85	1.20	1.95	1.35	1.25	1.75	.85	1.15	.50	.45	.50	.70
....	.80	2.60	4.90	1.35	1.80	1.70	.80	.95	.50	.45	.50	.70
....	.75	2.00	3.10	1.95	1.85	1.60	.80	.90	.50	.45	.50	.65
....	.70	1.75	2.55	1.95	1.95	1.45	.85	.90	.50	.40	.50	.60
....	.70	1.65	2.20	1.75	1.85	1.40	1.85	1.90	.50	.45	.50	.60
....	.65	1.60	2.05	1.65	1.75	1.35	1.00	1.15	.50	.45	.50	.60
....	.68	1.50	1.95	1.55	1.70	1.30	.90	1.00	.50	.45	.60	.60
....	.70	1.25	1.85	1.45	1.60	1.15	.85	.95	.50	.45	.70	.55

Mean daily gage height, in feet, of North (of James) River near Glasgow, Va., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	.95	1.25	1.75	1.35	1.55	1.15	.80	.90	.80	.45	.60	.50
16	.85	1.30	1.65	1.25	1.55	1.15	.70	.80	.65	.45	.60	.50
17	.50	1.30	1.55	1.20	1.45	1.45	.65	.70	.55	.40	.50	.50
18	.65	1.50	1.50	1.15	1.45	1.35	.65	.70	.50	.45	.50	.45
19	.60	1.75	1.45	1.15	4.90	1.30	.70	.75	.45	.45	.55	.40
20	.60	5.30	1.35	1.15	3.30	1.15	.65	.70	.40	.45	.55	.50
21	1.65	6.00	1.35	1.05	2.40	1.05	.65	.70	.40	.45	.60	.50
22	.90	7.50	1.35	1.00	2.10	2.05	.70	.75	.40	.45	.50	.50
23	3.80	7.20	1.35	.95	1.90	1.45	.80	.85	.40	.45	.50	.50
24	2.60	6.40	1.75	.95	1.80	1.05	.80	.75	.40	.40	.50	.50
25	2.10	1.95	1.70	.95	1.70	1.00	.90	.70	.40	.45	.50	.60
26	1.85	1.70	1.55	.95	1.70	1.00	.85	.70	.40	.45	.50	.60
27	1.65	1.55	1.60	2.15	1.60	1.00	.90	.60	.35	.45	.50	.80
28	1.58	1.55	1.60	3.50	1.55	1.35	.80	.55	.35	.45	.50	.90
29	1.50	1.35	1.45	2.90	1.45	1.15	.75	.50	.45	.45	.45	.80
30	1.50	.....	1.60	2.30	1.35	1.05	.75	.50	.40	.45	.60	.75
31	1.25	.....	1.55	.....	1.30	.....	.70	.50	.....	.40	.....	.60

Rating table for North (of James) River near Glasgow, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.35	125	1.10	510	2.50	1,810	3.90	4,120
.40	142	1.20	580	2.60	1,940	4.00	4,320
.45	160	1.30	650	2.70	2,080	4.10	4,530
.50	179	1.40	720	2.80	2,220	4.20	4,740
.55	199	1.50	800	2.90	2,370	4.30	4,960
.60	220	1.60	880	3.00	2,520	4.40	5,180
.65	242	1.70	970	3.10	2,680	4.50	5,410
.70	265	1.80	1,060	3.20	2,840	4.60	5,640
.75	290	1.90	1,150	3.30	3,010	4.70	5,880
.80	320	2.00	1,240	3.40	3,180	4.80	6,120
.85	350	2.10	1,340	3.50	3,360	4.90	6,370
.90	380	2.20	1,450	3.60	3,540	5.00	6,620
.95	410	2.30	1,560	3.70	3,730		
1.00	440	2.40	1,680	3.80	3,920		

The above table is applicable only for open-channel conditions. It is based upo 6 discharge measurements made during 1903 and 1904. It is well defined betwee gage heights 0.45 feet and 2.00 feet, and from gage height 2.00 to 5.00 feet a fa determination has been computed.

ated monthly discharge of North (of James) River near Glasgow, Va., for 1904.

[Drainage area, 831 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
uary	3,920	179	646	0.777	0.896
ruary	14,310	380	2,555	3.07	3.31
ch	6,370	685	1,218	1.47	1.69
il	3,360	410	890	1.07	1.19
	6,370	615	1,175	1.41	1.63
e	3,270	440	974	1.17	1.31
	1,105	242	404	.486	.560
;ust	1,240	179	370	.445	.513
tember	320	125	170	.205	.229
›ber	179	125	158	.190	.219
ember	265	142	183	.220	.245
ember	380	142	222	.267	.308
The year	14,310	125	747	.898	12.10

APPOMATTOX RIVER AT MATTOAX, VA.

'his station was established August 27, 1900, by E. W. Myers. It ocated on the two-span deck railroad bridge at Mattoax station, 27 es southeast of Richmond, on the road to Danville. It is equipped h a standard chain gage, which is attached to the outside of the ırd rail of the first span from the right bank. The length of the in from the end of the weight to the marker is 48.82 feet. A pernent bench mark, consisting of a United States Geological Survey ıdard iron post, was established August 29, 1903, by B. S. Drane. s post is set at the northwest corner of the Mattoax passenger sta-ı, with an elevation of 48.68 feet above gage datum. Bench mark 2 is on the outer upstream edge of the top of the upper chord of upstream truss, opposite the 2-foot mark on the gage scale. Its vation is 46.60 feet above gage datum. Discharge measurements made from the downstream side of the railroad bridge to which the ;e is attached. The initial point for soundings is the end of the vnstream guard rail at the right bank. Distances along this rail indicated by white paint. The channel is straight for 400 feet ›ve and for 100 feet below the station. The current is moderately ft. The right bank is high and is not subject to overflow. The bank is high, but overflows beneath the second span of the bridge ıigh water. The bed of the stream is composed of rock and sand,

and is clean and permanent. There is but one channel at all stag broken at extreme flood stages by the central pier of the bridge. T sand bottom beneath the second span is subject to change in high wat The gage is read once each day by J. C. Carter.

The observations at this station during 1904 have been made und the direction of N. C. Grover, district hydrographer.

Discharge measurements of Appomattox River at Mattoax, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Dischar
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-fe*
June 24	R. H. Bolster	66	150	1.37	1.23	2
August 4	N. C. Grover	70	209	1.40	2.01	2
October 4	R. H. Bolster	69	121	1.39	.81	1
October 22	J. C. Hoyt	68	183	1.48	1.72	2

Mean daily gage height, in feet, of Appomattox River at Mattoax, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	D
1	2.70	3.50	4.55	3.75	3.50	1.70	1.50	1.15	0.75	1.15	1.02	
2	2.50	3.65	4.25	3.40	3.00	4.45	1.40	1.50	1.25	1.05	1.07	
3	2.50	2.75	3.65	3.10	2.70	9.05	1.85	1.25	1.35	.90	1.10	
4	2.45	2.70	3.50	2.75	2.50	10.30	1.20	2.30	1.20	.80	1.12	
5	1.65	2.50	3.35	2.55	2.35	5.60	.90	1.30	.85	.80	1.22	
6	1.20	3.10	3.10	2.55	2.25	3.20	.80	1.20	1.35	.83	1.35	
7	1.92	6.25	4.90	2.70	2.25	2.50	.80	1.20	1.10	.85	1.42	
8	2.75	9.00	9.75	3.50	3.50	2.25	.75	.90	.90	.90	1.22	
9	2.60	7.00	11.70	3.55	5.35	2.05	.90	.80	.80	.85	1.22	
10	2.10	5.40	12.60	3.10	4.00	1.95	1.15	3.50	2.00	.83	1.18	
11	2.05	4.50	11.20	2.95	5.75	1.75	1.30	4.80	2.00	.90	1.18	
12	2.30	3.10	4.60	2.55	4.20	1.90	1.05	4.60	.95	.90	1.15	
13	3.15	2.70	4.20	2.45	3.05	1.70	1.02	2.45	.85	.88	1.60	
14	2.35	2.60	3.65	2.30	2.25	1.50	1.10	1.45	.75	.88	3.80	
15	2.25	2.50	4.10	2.25	3.05	1.40	1.15	1.10	14.00	.82	5.65	
16	2.25	2.75	3.75	2.30	6.10	1.35	.85	1.10	15.25	.88	3.20	
17	2.50	4.45	3.60	2.35	3.75	1.40	.80	.95	15.20	.79	2.35	
18	2.20	3.50	3.65	2.25	3.20	1.30	.85	1.00	4.00	.88	2.04	
19	1.85	2.40	3.50	2.10	5.10	1.40	.95	4.80	2.15	.85	1.72	
20	1.50	3.50	3.45	2.10	7.00	1.25	.60	5.70	1.80	.78	1.62	
21	1.85	5.50	3.15	2.05	4.30	1.15	.65	1.70	1.50	1.80	1.63	
22	3.05	8.30	3.55	2.00	3.25	1.15	1.10	1.30	1.35	1.82	1.52	
23	3.50	11.75	3.65	2.00	2.30	1.20	.80	2.70	1.25	1.39	1.63	
24	4.50	12.60	3.45	1.95	2.45	1.25	2.00	1.10	1.15	1.50	1.62	
25	3.80	12.85	3.45	2.00	2.20	1.05	4.80	1.00	1.15	1.10	1.73	
26	3.50	8.00	3.40	2.00	2.00	.95	3.75	.80	1.10	1.05	1.47	
27	3.20	4.60	4.25	2.95	1.85	.90	2.50	.80	1.10	1.12	1.40	
28	3.10	3.85	4.90	9.00	1.75	3.95	2.65	.70	1.05	1.15	1.32	
29	3.00	4.15	4.25	8.40	1.65	4.25	1.80	.70	1.00	1.20	1.33	
30	1.60	.....	3.60	4.45	1.65	3.00	2.00	.80	1.60	1.06	1.38	
31	1.65	.....	3.85	.....	1.50	.....	1.60	.80	.....	1.03	.....	

ating table for Appomattox River at Mattoax, Va., from August 25, 1900, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	140	2.70	496	6.00	1,490	10.60	3,624
.50	150	2.80	519	6.20	1,576	10.80	3,722
.60	160	2.90	542	6.40	1,662	11.00	3,820
.70	170	3.00	565	6.60	1,748	11.50	4,065
.80	180	3.10	590	6.80	1,834	12.00	4,310
.90	190	3.20	615	7.00	1,920	12.50	4,555
1.00	200	3.30	640	7.20	2,012	13.00	4,805
1.10	212	3.40	665	7.40	2,104	13.50	5,055
1.20	224	3.50	690	7.60	2,196	14.00	5,315
1.30	237	3.60	715	7.80	2,288	14.50	5,575
1.40	251	3.70	740	8.00	2,380	15.00	5,845
1.50	265	3.80	765	8.20	2,474	15.50	6,115
1.60	282	3.90	790	8.40	2,568	16.00	6,395
1.70	299	4.00	815	8.60	2,662	17.00	6,965
1.80	316	4.20	875	8.80	2,756	18.00	7,555
1.90	333	4.40	935	9.00	2,850	19.00	8,170
2.00	350	4.60	995	9.20	2,946	20.00	8,815
2.10	370	4.80	1,065	9.40	3,042	21.00	9,490
2.20	390	5.00	1,135	9.60	3,138	22.00	10,200
2.30	410	5.20	1,205	9.80	3,234	23.00	10,930
2.40	430	5.40	1,275	10.00	3,330	24.00	11,700
2.50	450	5.60	1,345	10.20	3,428		
2.60	473	5.80	1,415	10.40	3,526		

The above table is applicable only for open-channel conditions.

Estimated monthly discharge of Appomattox River at Mattoax, Va., for 1904.

[Drainage area, 745 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	965	224	465	0.624	0.719
February	4,730	430	1,369	1.84	1.98
March	4,605	590	1,192	1.60	1.84
April	2,850	342	639	.858	.957
May	1,920	265	665	.893	1.03
June	3,477	190	584	.784	.875
July	1,065	160	283	.380	.438
August	1,380	170	368	.494	.570
September	5,980	175	806	1.08	1.20
October	319	178	206	.277	.319
November	1,362	202	325	.436	.487
December	2,251	248	732	.983	1.13
The year	5,980	160	636	.854	11.545

ROANOKE RIVER DRAINAGE BASIN.

Roanoke River proper is formed by the confluence of Dan and Staunton rivers at Clarksville, Mecklenburg County, Va., 185 miles above the mouth of the stream, though the name "Roanoke" is also applied to the upper waters of Staunton River. These streams drain, respectively, 3,798 and 3,546 square miles. Staunton River is the more northerly of the two, its drainage basin lying entirely in Virginia. It rises among the eastern foothills of the Blue Ridge southwest of Roanoke and Salem, being known in this part of its course as the Roanoke, and flows at first northeast, then southeast through Montgomery, Roanoke, Bedford, Campbell, Halifax, and Mecklenburg counties to the junction with the Dan.

A large part of the area drained by the Dan lies in North Carolina. The stream rises in Surry County, N. C., and in Patrick County, Va., and flows at first southeast through Stokes County, N. C., then northeast through Rockingham and Caswell counties, N. C., and through Pittsylvania, Halifax, and Mecklenburg counties, Va., to the junction with the Staunton.

Roanoke River drains a total area of about 9,200 square miles and empties into Albemarle Sound a short distance below Plymouth, N. C.

It is navigable at all stages for 120 miles to Weldon, N. C., where the river crosses the fall line.

The rainfall on the basin above the fall line is about 48 inches per annum and is evenly distributed throughout the year. The average amount probably increases slightly as the stream is ascended, though the records of rainfall over the basin are too incomplete to decide this matter. The slopes in the headwaters and in the upper tributaries are steep, freshets on the river are violent, and the fluctuations of height occur with great rapidity. Rises of 50 feet and over have been noted at Weldon, and freshets in which the rate of rise is 10 feet a day or more are frequent.

The United States Weather Bureau maintains gages on Roanoke River at Clarksville, Va., and Weldon, N. C., and on Dan River at Danville, Va. Gaging stations were maintained by the United States Geological Survey during 1904 as follows: Roanoke (upper portion of Staunton) at Roanoke, Va.; Staunton at Randolph, Va.; Banister at Houston, Va.; Dan at South Boston, Va.; Dan at Madison, N. C., and Mayo at Madison, N. C.

ROANOKE RIVER AT ROANOKE, VA.

This station was established July 10, 1896, by D. C. Humphreys. The original gage of the wire type was replaced November 28, 1903, by a standard chain gage installed by W. C. Sawyer. The datum is the same as that of the gage which it replaced. The length of the chain from the end of the weight to the marker is 27.50 feet. Bench mark No. 1 is the downstream upper edge of the second floor beam from the left abutment. Its elevation is 21.98 feet above gage datum. Bench mark No. 2 is a standard copper bolt set in the face of the lower wing wall of the left abutment, about 4 feet above the ground. Its elevation is 19.70 feet above gage datum. Discharge measurements were made from the Walnut Street Bridge, at which the gage is located, up to July 21, 1903. Since that time they have been made from the Jefferson Street Bridge, at which the section is more suitable. The initial point for soundings is the left end of the downstream hand rail. The channel is nearly straight and has a width of 160 feet between abutments, broken by one pier. The current is rapid. The bed of the stream is composed of coarse gravel and small bowlders. The right bank is above high water, but the left is liable to overflow at extreme flood stages. The gage is read once daily by Richard P. Royer.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Roanoke River at Roanoke, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 20	F. H. Brundage	111	269	1.09	1.32	294
August 8	N. C. Grover	113	345	1.37	1.67	473
September 16	R. H. Bolster	108	214	.59	.80	129
September 29	do	106	186	.49	.68	93
October 18	do	105	170	.44	.63	76

Mean daily gage height, in feet, of Roanoke River at Roanoke, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.95	0.75	1.75	1.15	1.05	2.45	2.10	1.50	0.85	0.65	0.65	0.70
2	.90	.75	1.80	1.10	1.05	3.25	1.50	1.70	1.20	.65	.65	.70
3	.80	.80	1.65	1.05	1.05	1.95	1.20	1.40	1.30	.60	.65	.75
4	.30	.95	1.55	1.05	1.05	1.45	1.00	1.50	.95	.60	.65	.90
5	1.05	.70	1.45	1.05	1.05	1.55	1.10	1.60	.95	.65	.75	.80
6	.65	.95	1.35	1.00	1.10	1.35	1.00	2.60	.90	.60	.70	1.00
7	.80	1.15	2.55	1.00	1.10	1.25	1.00	1.65	.85	.60	.75	1.00
8	.80	1.80	2.75	1.10	1.20	1.35	1.00	1.70	.80	.65	.75	.90
9	.80	1.40	2.05	1.15	1.20	1.15	.95	2.00	.80	.65	.75	.80
10	.80	1.25	1.80	1.15	1.30	2.05	1.50	3.00	.80	.65	.70	.80
11	.90	1.10	1.65	1.10	1.25	1.55	1.20	3.60	.75	.65	.70	.75
12	.90	1.10	1.45	1.25	1.15	1.75	1.10	2.40	.80	.65	.70	.70
13	.80	1.05	1.45	1.20	1.10	1.45	.95	1.60	.80	.65	.75	.70
14	.80	1.10	1.40	1.10	1.05	1.35	.90	1.40	.80	.65	.90	.70
15	.30	.95	1.40	1.15	1.15	1.20	.80	1.40	.90	.60	.85	.70
16	.85	.85	1.30	1.05	1.10	1.30	.80	1.40	.85	.65	.75	.70
17	.85	1.05	1.25	1.05	1.05	1.55	.70	1.15	.75	.65	.80	.75
18	.60	.90	1.20	.95	1.10	1.45	.70	1.15	.75	.65	.80	.75
19	1.35	.95	1.20	1.05	2.35	1.25	.70	1.10	.75	.65	.75	.70
20	.60	1.10	1.15	1.05	1.95	1.40	.70	1.15	.75	.65	.75	.65
21	.80	.95	1.15	.90	1.65	1.60	.70	1.00	.75	.65	.75	.65
22	.85	1.10	1.10	.85	1.45	1.40	.70	1.00	.75	.65	.75	.65
23	1.45	1.80	1.10	1.05	1.35	1.20	1.00	1.00	.70	.65	.75	.65
24	1.25	1.50	1.25	.75	1.25	1.10	1.20	.95	.70	.65	.75	.70
25	1.05	1.30	1.25	.85	1.25	1.00	.95	.95	.70	.65	.75	.70
26	1.05	1.25	1.25	.95	1.55	1.00	1.70	.90	.70	.65	.70	.80
27	.90	1.15	1.25	.95	1.35	1.40	1.30	.90	.70	.65	.70	.80
28	.85	1.10	1.25	1.45	1.25	1.40	2.75	.85	.70	.70	.70	.80
29	.95	1.35	1.20	1.15	1.05	1.20	1.50	.90	.70	.65	.70	.80
30	.85	.....	1.15	1.15	1.05	1.20	1.30	.85	.70	.65	.70	.70
31	.75	.....	1.15	.....	1.65	.....	1.20	.85	.....	.65	.....	.70

Rating table for Roanoke River at Roanoke, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	43	0.95	167	2.20	850	4.00	2,905
.35	47	1.00	181	2.30	940	4.20	3,175
.40	52	1.10	212	2.40	1,030	4.40	3,445
.45	58	1.20	247	2.50	1,130	4.60	3,715
.50	65	1.30	286	2.60	1,230	4.80	3,985
.55	73	1.40	330	2.70	1,330	5.00	4,255
.60	82	1.50	380	2.80	1,435	5.20	4,525
.65	92	1.60	430	2.90	1,545	5.40	4,795
.70	103	1.70	490	3.00	1,660	5.60	5,065
.75	115	1.80	550	3.20	1,900	5.80	5,335
.80	127	1.90	620	3.40	2,140	6.00	5,605
.85	140	2.00	690	3.60	2,390	7.00	6,955
.90	153	2.10	770	3.80	2,645	8.00	8,305

The above table is applicable only for open-channel conditions. It is based upon scharge measurements made during 1896 to 1904. It is well defined between gage eights 0.60 feet and 7 feet. The table has been extended beyond these limits. bove gage height 4 feet the rating curve is a tangent, the difference being 135 per nth.

Estimated monthly discharge of Roanoke River at Roanoke, Va., for 1904.

[Drainage area, 388 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	355	43	150	0.387	0.446
February	550	103	229	.590	.636
March	1,380	212	395	1.02	1.18
April	355	115	202	.521	.581
May	985	196	292	.753	.868
June	1,960	181	417	1.07	1.19
July	1,380	103	264	.680	.784
August	2,390	140	453	1.17	1.35
September	286	103	133	.343	.382
October	103	82	91	.235	.271
November	153	92	111	.286	.319
December	181	92	118	.304	.350
The year	2,390	43	238	.613	8.358

STAUNTON RIVER AT RANDOLPH, VA.

This station was originally established August 27, 1900, by E. W. Myers, and is located on the railroad bridge about five-eighths of a mile southwest of the Southern Railway station at Randolph, Va. The present gage was installed by B. S. Drane, May 20, 1903. It is a standard chain gage, and occupies practically the same position as the wire gage which it replaced. It is attached to the upstream guard rail in the middle of the second span from the left bank. The datum is the same as that of the original gage. The length of the chain from the end of the weight to the marker is 43.13 feet. Bench mark No. 1 is the top of the floor beam nearest the zero of the gage scale, at a point 0.2 foot downstream from the adjacent tie. Its elevation is 42.01 feet above the gage datum. Bench mark No. 2 is a copper bolt set in the capstone on the downstream side of the left abutment, about 3 feet from the end of the ties. Its elevation is 37.01 feet above gage datum. Discharge measurements are made from the bridge to which the gage is attached. The current is moderately rapid and has a well-distributed velocity. The channel is straight for a considerable distance above and below the station, and has a width at ordinary stages of above 400 feet, broken by one bridge pier. The bed is composed mainly of firm material, and is permanent. The bridge makes a small angle with the normal to the direction of the current. The gage is read once daily by J. E. Figg, the station agent.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Staunton River at Randolph, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 22	F. H. Brundage	233	865	2.37	4.47	2,049
September 27	R. H. Bolster	220	468	1.68	2.70	787
October 22	do	224	517	1.59	2.92	822

Mean daily gage height, in feet, of Staunton River at Randolph, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.5	3.9	5.4	4.5	4.9	11.8	6.2	5.9	4.6	2.7	2.9	3.4
2	4.6	4.2	5.2	4.4	5.1	12.2	5.8	6.0	4.8	2.8	2.8	3.7
3	4.5	4.4	5.0	4.3	5.0	8.6	5.6	6.2	4.9	2.9	2.7	3.9
4	4.4	4.8	5.1	4.4	5.2	6.9	5.4	6.4	4.7	3.0	2.8	3.8
5	4.5	5.2	5.2	4.5	5.1	5.6	4.2	7.9	4.5	2.9	2.9	3.7
6	4.6	7.1	5.0	4.6	5.1	5.4	4.3	8.2	4.6	3.1	3.0	3.8
7	4.4	7.4	5.4	4.5	5.4	5.2	3.9	6.8	4.4	2.9	3.1	3.9
8	4.2	7.2	5.6	4.4	5.6	5.1	3.6	5.5	4.2	2.8	3.0	3.9
9	4.0	6.9	5.9	4.3	5.8	4.9	3.5	6.6	3.9	2.7	3.2	4.2

Main daily gage height, in feet, of Staunton River at Randolph, Va., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
0	4.1	6.6	6.1	4.4	6.0	5.0	3.6	9.4	4.0	2.9	3.6	4.1
1	4.3	6.2	6.2	4.4	6.2	4.8	3.4	9.2	4.1	2.8	3.9	4.2
2	4.5	5.6	6.4	4.5	5.8	4.9	3.5	5.6	4.6	2.7	4.3	4.4
3	4.4	5.1	6.2	4.4	5.4	5.2	3.6	4.5	5.8	2.6	4.9	4.8
4	4.7	4.6	5.9	4.5	4.9	4.7	3.7	4.2	6.4	2.7	4.7	4.5
5	4.8	4.8	5.7	4.7	4.3	4.9	3.8	3.9	6.1	2.6	4.6	4.6
6	4.9	5.1	5.6	4.8	5.7	5.1	3.6	3.6	5.4	2.7	4.3	4.4
7	4.6	5.3	5.5	4.6	6.9	5.3	3.5	3.5	4.2	2.6	3.7	4.2
8	4.4	6.1	5.2	4.4	8.4	5.0	3.3	3.7	4.1	2.5	3.3	4.1
9	4.2	6.8	5.0	4.3	7.2	5.1	3.1	3.9	3.8	2.6	3.1	3.8
0	3.8	7.4	4.8	4.1	6.5	5.3	3.2	4.1	3.6	2.7	3.2	3.7
1	4.2	8.2	5.0	4.0	5.6	5.5	3.0	4.2	3.7	3.4	3.3	3.9
2	4.8	10.4	5.3	3.9	5.4	5.2	2.8	4.4	3.4	2.9	3.2	4.3
3	5.3	9.6	5.6	3.8	5.5	5.2	2.7	4.3	3.1	2.8	3.1	4.8
4	5.4	8.2	5.4	3.9	5.3	5.4	3.3	4.5	3.0	2.7	2.9	5.2
5	5.2	6.8	5.1	3.8	4.9	5.3	3.9	4.6	2.8	2.7	3.0	5.1
6	4.9	6.2	4.9	5.9	4.6	5.5	5.8	4.8	2.9	2.8	3.1	4.9
7	4.6	5.8	4.7	7.1	4.4	5.7	7.6	4.5	2.7	2.9	3.0	4.7
8	4.3	5.4	4.5	6.9	4.2	5.8	8.1	4.7	2.9	2.8	3.2	4.5
9	4.0	5.3	4.6	5.7	4.0	6.7	7.2	4.9	2.8	2.7	3.1	4.2
0	3.9	.....	4.5	4.8	3.8	6.4	6.7	5.2	2.8	2.8	3.3	4.3
1	3.8	.....	4.4	.....	6.9	.....	5.8	5.1	.....	2.7	.....	3.9

Rating table for Staunton River at Randolph, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.50	590	3.90	1,620	5.30	2,775	7.40	4,720
2.60	655	4.00	1,700	5.40	2,860	7.60	4,920
2.70	725	4.10	1,780	5.50	2,950	7.80	5,120
2.80	795	4.20	1,860	5.60	3,040	8.00	5,320
2.90	865	4.30	1,940	5.70	3,130	8.50	5,820
3.00	935	4.40	2,020	5.80	3,220	9.00	6,340
3.10	1,005	4.50	2,100	5.90	3,310	9.50	6,865
3.20	1,080	4.60	2,180	6.00	3,400	10.00	7,390
3.30	1,155	4.70	2,265	6.20	3,580	10.50	7,915
3.40	1,230	4.80	2,350	6.40	3,770	11.00	8,440
3.50	1,305	4.90	2,435	6.60	3,960	11.50	8,980
3.60	1,380	5.00	2,520	6.80	4,150	12.00	9,530
3.70	1,460	5.10	2,605	7.00	4,340		
3.80	1,540	5.20	2,690	7.20	4,530		

The above table is applicable only for open-channel conditions. It is based upon 14 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 2.70 feet and 4.60 feet. The table has been extended beyond these limits. Above gage height 4.60 feet the rating curve is probably accurate to within 10 per cent.

Estimated monthly discharge of Staunton River at Randolph, Va., for 1904.

[Drainage area, 3,076 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	2,860	1,540	2,087	0.678	0.782
February	7,810	1,620	3,667	1.19	1.28
March	3,770	2,020	2,787	.906	1.04
April	4,435	1,540	2,224	.723	.807
May	5,720	1,540	2,939	.955	1.10
June	9,750	2,265	3,397	1.10	1.23
July	5,420	725	2,117	.688	.793
August	6,760	1,305	2,899	.942	1.09
September	3,770	725	1,801	.586	.654
October	1,230	590	787	.256	.295
November	2,435	725	889	.289	.322
December	2,690	1,230	1,881	.612	.706
The year	9,750	590	2,290	.744	10.10

DAN RIVER AT MADISON, N. C.

This station was established May 14, 1903, by E. W. Myers. It is located at the Southern Railway bridge about one-fourth mile from Madison and one-half mile above the mouth of Mayo River. The standard chain gage is located on the upstream side of the bridge in the sixth panel of the first span from the left end. The length of the chain from the end of the weight to the marker is 35.24 feet. Bench mark No. 1 is the edge of the top of a large wire nail driven flush into the top corner of the wooden floor beam beneath the gage box on the upstream side of the bridge. The point is indicated by the letters "B. M." in white paint. When the gage reads zero, the water surface is 34.10 feet below this bench mark. Bench mark No. 2 is a standard iron bench-mark post set in cleared level ground on the lef or south side of the railway track. It is 77 feet west of the initia point for soundings, and 9 feet south of the south rail of the track Its elevation above the water surface when the gage reads zero 36.21 feet. Discharge measurements are made from the upstream sid of the covered wooden two-span railway bridge and its wooden ap proaches. The initial point for soundings is the end of the guard ra of the trestle over the left bank. Distances are measured along th upstream guard rail and are marked with white paint. Above th station the channel is straight for about 600 feet and the velocity c

he current is good. About 300 feet below the station the channel makes an abrupt turn. The right bank is low and overflows. There is a long trestle approach to the bridge on this side, and all water passes beneath the bridge and approaches. The left bank is low and overflows.

There is a small stream entering from this side. The bed of the stream is sandy and probably permanent. There is but one channel at all stages. The gage is read once each day by B. F. Reynolds.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrograper.

Discharge measurements of Dan River at Madison, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
January 23	B. S. Drane	151	405	1.90	2.18	772
March 10	do	151	321	1.97	1.80	631
Do	do	151	318	1.96	1.79	623
April 15	do	149	224	1.83	1.06	411
April 16	do	149	224	1.84	1.09	412
June 6	do	150	196	1.81	.90	356
Do	do	150	198	1.82	.90	361
June 7	do	152	344	1.98	1.90	682
September 26	do	148	159	1.59	.50	254
September 27	do	148	159	1.59	.52	254
December 19	do	148	150	1.85	.58	278
December 20	do	148	159	1.98	.65	314

Mean daily gage height, in feet, of Dan River at Madison, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	1.00	1.50	1.65	1.00	2.40	1.80	1.20	1.50	0.35	0.30	0.50
2	.95	.55	1.50	1.55	1.00	2.70	1.20	3.80	1.85	.30	.30	.45
3	1.00	.95	1.45	1.40	1.00	1.90	.85	3.25	1.50	.30	.30	1.45
4	.60	.80	1.40	1.30	1.00	1.45	.75	1.85	1.20	.30	.35	1.10
5	.55	.80	1.35	1.25	.90	1.10	.70	1.00	1.40	.30	.80	.75
6	.65	1.35	1.20	1.20	.90	.90	.90	2.20	1.10	.30	.70	2.50
7	1.00	1.60	1.40	1.40	.90	2.30	1.00	5.40	.80	.30	.40	1.50
8	1.00	4.05	4.80	1.60	2.00	1.20	.80	3.60	.80	.25	.40	1.20
9	.85	2.35	2.45	1.50	1.55	1.10	.70	2.20	.80	.20	.40	.80
10	.90	1.60	1.90	1.60	1.80	.80	.75	5.20	.70	.20	.40	.75
11	1.10	1.20	1.70	1.30	1.35	4.00	1.00	2.80	1.00	.20	.35	.65
12	1.00	1.20	1.55	1.25	1.10	3.10	1.10	2.20	.80	.20	.30	.60
13	1.10	1.10	1.40	1.10	1.00	2.00	1.35	1.60	.60	.20	.50	.55
14	1.00	1.25	1.45	1.15	.90	1.30	.90	1.20	1.00	.20	.50	.50
15	.75	1.30	1.60	1.10	1.60	1.10	.50	1.10	1.00	.20	.55	.50
16	.70	1.20	1.35	1.15	1.10	.90	.40	3.70	1.20	.20	.60	.50
17	.90	.80	1.10	1.10	.90	2.20	.55	1.85	1.10	.20	.55	.70
18	.75	.90	1.25	1.00	7.30	1.80	.50	1.30	1.10	.20	.50	.70

Mean daily gage height, in feet, of Dan River at Madison, N. C., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
19	.65	1.20	1.40	1.00	3.10	3.70	.40	1.00	1.00	.20	.50	.60
20	.70	2.65	1.20	1.00	1.80	1.50	.45	4.00	.50	.25	.50	.60
21	1.15	1.75	1.20	.90	1.40	1.30	.50	5.90	.50	.30	.50	.60
22	1.05	5.50	1.30	.90	1.25	2.20	2.70	2.45	.50	.30	.45	.60
23	2.05	4.05	1.25	.85	1.10	1.25	1.90	1.65	.50	.30	.50	.50
24	1.50	2.80	10.30	.80	1.00	.90	2.70	1.50	.50	.30	.45	.85
25	1.25	2.05	3.90	.90	1.05	.80	1.50	1.35	.40	.30	.45	.95
26	1.10	1.65	2.50	1.00	1.00	.70	1.00	1.20	.40	.30	.40	1.00
27	1.00	1.60	2.50	2.00	.90	.60	1.20	1.10	.40	.30	.40	1.30
28	.75	1.50	2.70	1.90	.90	.90	1.40	1.00	.40	.30	.40	2.65
29	.35	1.50	2.10	1.35	.80	3.90	3.00	.90	.40	.30	.45	1.98
30	1.15	.....	1.80	1.20	.80	2.40	2.30	.90	.40	.30	.50	1.40
31	1.05	.....	1.60	.....	.80	.....	3.50	.80	.....	.30	.....	1.10

Rating table for Dan River at Madison, N. C., from May 7, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.20	180	0.60	278	1.00	386	1.80	642
.25	192	.65	291	1.10	416	1.90	676
.30	204	.70	304	1.20	446	2.00	710
.35	216	.75	317	1.30	476	2.10	744
.40	228	.80	330	1.40	508	2.20	778
.45	240	.85	344	1.50	540	2.30	813
.50	252	.90	358	1.60	574	2.40	849
.55	265	.95	372	1.70	608	2.50	885

The above table is applicable only for open-channel conditions. It is based upon 10 discharge measurements made during 1904 and 4 measurements made during 1903. It is well defined between gage heights 0.50 foot and 2.50 feet.

Discharge estimated above 2.50 gage height.

Estimated monthly discharge of Dan River at Madison, N. C., for 1903–4.

Month	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1903.			
May 8–31	2,465	574	992
June	3,300	710	1,199
July	2,735	416	742
August	4,250	401	910
September	2,495	358	541
October	813	330	398
November	1,020	317	418
December	795	265	388

timated monthly discharge of Dan River at Madison, N. C., for 1903–4—Continued.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1904.			
nuary	727	216	376
bruary	2,375	265	659
arch	5,255	416	808
pril	710	330	463
ay	3,455	330	550
ne	1,575	278	653
ly	1,335	228	480
ugust	2,615	330	865
eptember	659	228	349
ctober	216	180	195
ovember	330	204	242
ecember	953	240	386
The year	5,255	180	502

DAN RIVER AT SOUTH BOSTON, VA.

This station, which was established on August 27, 1900, by E. W. lyers, is in the town of South Boston, Va., on the railroad bridge of e Norfolk and Western Railroad which crosses the river at that lace. On May 18, 1903, B. S. Drane replaced the wire gage with a andard chain gage. The datum was not changed. The gage is cated on the downstream guard rail near the center of the first span om the left bank. The length of the chain from the end of the eight to the marker is 35.02 feet. Bench mark No. 1 is the sharp ner corner toward the left bank of the plate attached to the inner rface of the struts at the center of the left span and to the bearing f the wooden floor beam and tie. The elevation of the top of the late is 32.86 feet above gage datum. Bench mark No. 2 is the top f a standard copper bolt set in the capstone of the abutment of the iaduct by means of which the Southern Railway crosses the highway short distance upstream from the Norfolk and Western and Southern ailway crossing. Its elevation is 30.65 feet above gage datum.

Discharge measurements are made from the bridge to which the age is attached. The initial point for soundings is the left end of he downstream guard rail. This is a very good station for the gaging f all except the very highest stages of flow. At extreme heights the iver spreads out over a flood plain of considerable width. The trestle onnecting the bridge with the embankment on the south side of the iver is on a curve of rather high degree. The bed of the stream is of

coarse sand and probably shifts only slightly. The gage is read tw daily by J. Mercer East.

The observations at this station during 1904 have been made unc the direction of N. C. Grover, district hydrographer.

Discharge measurements of Dan River at South Boston, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Dischar
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-fe*
June 21	F. H. Brundage	253	1,542	1.57	2.68	2,
September 15	R. H. Bolster	295	3,820	2.85	10.82	10,
September 28	do	243	1,152	1.20	1.22	1,
October 20	J. C. Hoyt	238	1,015	.89	.745	

Mean daily gage height, in feet, of Dan River at South Boston, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	D
1	1.95	2.15	2.40	2.25	2.30	3.20	3.10	4.67	1.25	1.28	0.35	1
2	1.85	1.80	2.20	2.25	1.80	4.99	2.90	4.60	2.37	.72	.68	1
3	2.10	2.05	2.15	2.20	1.40	5.45	2.47	5.00	4.75	.20	.98	1
4	1.75	1.90	2.30	2.00	1.70	3.55	1.95	3.77	4.02	.42	1.02	
5	1.62	2.10	2.25	1.75	1.45	2.45	1.35	2.00	2.79	.47	1.02	
6	a.55	2.25	2.35	1.65	1.40	1.80	.92	1.67	2.10	.95	.72	
7	.62	2.20	3.50	1.75	1.90	2.65	.87	1.57	1.30	.67	.42	
8	1.45	6.10	4.55	1.80	1.80	3.15	1.57	4.80	.95	.37	.68	
9	2.07	6.05	4.95	1.70	1.65	2.55	1.05	7.25	1.72	.15	1.12	
10	1.90	3.80	4.20	1.90	1.80	1.95	.92	11.15	1.32	.02	1.18	1
11	2.05	2.95	3.25	1.95	1.80	1.80	1.32	9.70	1.05	−.05	1.20	1
12	2.17	2.70	2.65	1.70	1.80	3.55	1.55	6.15	.92	.62	1.02	1
13	2.07	2.05	2.60	1.50	1.50	4.85	1.60	3.75	1.47	.63	1.78	1
14	2.00	1.90	2.50	1.40	1.50	2.63	1.42	2.65	3.97	.65	2.88	1
15	1.82	2.15	2.45	1.40	2.40	1.73	1.22	1.82	10.75	.68	2.38	1
16	1.55	2.30	2.40	1.40	2.40	1.43	1.22	1.52	9.05	.28	1.68	1
17	1.45	1.55	2.25	1.45	3.70	1.40	.87	1.27	3.27	.02	1.58	1
18	1.42	1.60	2.10	1.40	4.05	1.33	.65	1.37	1.82	.25	1.48	1
19	1.55	2.05	2.05	1.35	8.00	1.30	.92	1.40	1.07	.70	1.42	1
20	1.27	4.20	2.10	1.35	4.40	1.23	.67	1.52	1.37	.62	.88	1
21	1.45	4.00	1.80	1.30	2.70	2.50	.68	1.37	1.37	.52	.48	1
22	1.70	8.50	1.65	1.30	2.25	2.05	.77	3.77	1.37	1.42	.58	1
23	2.85	11.05	2.10	1.30	1.70	1.78	2.15	3.37	1.37	.68	1.62	1
24	3.00	8.05	5.45	1.30	1.60	1.48	4.67	2.27	1.37	.38	1.52	1
25	2.90	4.55	9.70	1.30	1.55	1.28	6.30	1.50	1.12	.35	1.50	1
26	2.10	3.80	5.30	1.35	1.50	1.02	2.50	1.37	1.13	1.18	1.40	1
27	1.95	3.05	4.05	1.60	1.35	.85	2.05	1.27	1.32	1.05	.82	2
28	1.75	3.15	3.80	2.35	1.30	1.32	2.10	1.05	1.32	.85	.38	2
29	.82	2.55	3.55	3.25	1.15	1.95	2.97	.72	1.28	.68	1.18	1
30	.88	.....	2.80	2.80	1.10	2.77	4.17	.85	1.22	.45	1.42	1
31	1.08	.....	2.45	.....	1.00	.....	4.52	1.07	.....	.28	.....	1

a Ice.

ting table for Dan River at South Boston, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.00	400	1.70	1,635	3.40	2,989	6.20	5,453
.10	451	1.80	1,713	3.50	3,070	6.40	5,644
.20	510	1.90	1,791	3.60	3,152	6.60	5,838
.30	574	2.00	1,870	3.70	3,234	6.80	6,034
.40	642	2.10	1,949	3.80	3,317	7.00	6,234
.50	713	2.20	2,028	3.90	3,400	7.20	6,434
.60	786	2.30	2,107	4.00	3,484	7.40	6,638
.70	861	2.40	2,186	4.20	3,653	7.60	6,845
.80	937	2.50	2,265	4.40	3,824	7.80	7,055
.90	1,014	2.60	2,345	4.60	3,997	8.00	7,275
1.00	1,091	2.70	2,425	4.80	4,172	8.50	7,830
1.10	1,168	2.80	2,505	5.00	4,349	9.00	8,415
1.20	1,245	2.90	2,585	5.20	4,528	9.50	9,030
1.30	1,323	3.00	2,665	5.40	4,709	10.00	9,700
1.40	1,401	3.10	2,746	5.60	4,892	10.50	10,420
1.50	1,479	3.20	2,827	5.80	5,077	11.00	11,190
1.60	1,557	3.30	2,908	6.00	5,264	11.50	11,990

The above table is applicable only for open-channel conditions. It is based upon ischarge measurements made during 1903 and 1904. It is fairly well defined. The able has been extended below gage height 0.75 foot.

Estimated monthly discharge of Dan River at South Boston, Va., for 1904.

[Drainage area, 2,750 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	2,665	750	1,663	0.605	0.697
February	11,270	1,518	3,239	1.18	1.27
March	9,290	1,596	2,847	1.04	1.20
April	2,868	1,323	1,663	.605	.675
May	7,275	1,091	1,999	.727	.838
June	4,755	976	2,147	.781	.871
July	5,548	824	1,877	.683	.788
August	11,430	876	2,901	1.05	1.21
September	10,795	1,029	2,250	.818	.913
October	1,417	375	772	.281	.324
November	2,569	608	1,233	.448	.500
December	4,510	1,245	1,953	.710	.819
The year	11,430	375	2,045	.744	10.11

MAYO RIVER AT MADISON, N. C.

This station was established as a bench-mark station April 16, 1904, by B. S. Drane. It is located about one-half mile from Madison, N. C., at the highway bridge on the road to Mayodan, N. C., and about 1,000 feet above the junction of Mayo and Dan rivers. Discharge measurements are made from the downstream side of the two-span bridge resting on three stone piers. The initial point for soundings is over the left end of the bridge, downstream side. The channel is straight for about 600 feet above and 1,000 feet below the station. The current is swift. Both banks are high, wooded, and not liable to overflow. The bed of the stream is composed of sand, with some rock along the left bank. There is but one channel. At low stages all water passes under the left span; at higher stages, under both spans. Two cotton mills about 3 miles upstream will control the flow at all times, and freshets in Dan River will also cause backwater at the station. The bench mark is the upper edge of a small tie plate on the upstream side of the bottom of the third strut from the left bank on the upstream side of the bridge. Its elevation is 28 feet above datum.

Discharge measurements of Mayo River at Madison, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 16	B. S. Drane	59	249	1.13	1.82	281
June 7	do	60	270	.90	2.09	244
September 27	do	61	250	.81	1.24	202

BANISTER RIVER AT HOUSTON, VA.

This river, which drains a total area of 520 square miles, has its headwaters in Pittsylvania County, Va., flows southwesterly through this and Halifax counties, and is tributary to Dan River at a point about 5 miles below South Boston. The basin is hilly and generally in farming lands, with small forest areas. This station was established September 28, 1904, by R. H. Bolster, and is located at a covered highway bridge one and a fourth miles below the railway station at Houston, Va., and about one-fourth of a mile below the mouth of Terrible Creek. A standard chain gage is attached to the upstream side of the bridge near the left pier; the length of chain is 33.50 feet. A board gage at the mouth of Terrible Creek has been set to read the same as the chain gage at 2.3 feet above gage datum and has been used since November 27. A high-water gage from 19 to 30 feet is painted on the northeast corner of Mr. Yates's mill.

The datum of the chain gage is referred to bench marks as follows: No. 1, chiseled cross at the top of the left abutment, upstream side of bridge; elevation, 25.27 feet. No. 2, top of foundation at northeast corner of Mr. Yates's mill, directly under the high-water gage; elevation, 19.12 feet. No. 3, nail in 10-inch tree 50 feet northeast of bridge over Terrible Creek; elevation, 16.48 feet.

The channel is straight for about 1,000 feet above and below the station. Both banks are low and liable to overflow. The bed of the stream is of gravel and sand, and probably changes somewhat. There is one channel, broken by one pier at low water and by two piers at medium stages. The gage is read twice daily by J. A. Yates.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Banister River at Houston, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
September 28	R. H. Bolster	73	126	1.44	2.31	181
October 22	do	72	131	1.24	2.30	162

Mean daily gage height, in feet, of Banister River at Houston, Va., for 1904.[a]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	2.05	2.12	2.32	12	2.00	2.25	2.65	23		2.15	2.38	2.78
2	2.00	2.22	2.32	13	1.95	2.92	2.68	24		2.10	2.38	2.98
3	2.00	2.20	3.08	14	1.95	4.05	2.40	25		2.00	2.32	3.65
4	2.00	2.25	3.15	15	1.95	3.10	2.38	26		2.20	2.32	3.35
5	2.05	2.52	3.80	16	1.90	2.65	2.48	27		2.20	2.30	3.50
6	2.00	2.48	6.08	17	2.00	2.48	2.68	28	2.15	2.12	2.30	3.88
7	2.00	2.32	4.60	18	1.90	2.35	2.85	29	2.70	2.15	2.30	3.55
8	2.00	2.28	3.40	19	2.05	2.35	2.72	30	2.28	2.10	2.32	2.95
9	1.90	2.28	3.05	20	2.00	2.30	2.85	31		2.10		2.98
10	2.00	2.20	2.90	21	2.35	2.30	2.80					
11	1.95	2.25	2.75	22	2.30	2.35	2.62					

[a] Gage heights from September 28 to November 26 refer to the bridge gage. For the remainder of the year they refer to the gage at the mouth of Terrible Creek.

PEDEE, OR YADKIN, RIVER DRAINAGE BASIN.

The Yadkin River, or the Pedee, as it is called below the junction with the Uharie, rises on the eastern slope of the Blue Ridge, in Caldwell and Watauga counties, N. C., and flows at first southeast, then turns abruptly northeast and flows in this direction for about 60 miles, then bends again abruptly and flows south and southeast across North Carolina and South Carolina, emptying into Winyah Bay at Georgetown, S. C. The total length of the stream, from source to

mouth, following its general direction, is from 275 to 300 miles, while it is probably 400 miles or more if all the windings be followed.

The Pedee drains a total area of about 17,000 square miles, of which about 9,700 square miles are in North Carolina and 7,300 in South Carolina. The stream crosses the fall line near Cheraw, S. C., in a series of rapids extending over a number of miles, with no very great fall at any one place or in any short distance.

Small amounts of power may be developed on some of the tributaries of this stream in South Carolina, but the power possibilities of the basin in this State are unimportant. In North Carolina the stream can be made to furnish power in large quantities at a number of places, and large amounts may be secured on many of the tributaries. This stream and its tributaries are among the most important power streams in the Southern States.

Below the great bend, where the river turns to the south, the valley of the stream averages about 50 miles in width. At many points the river is bordered by wide expanses of bottom lands, which are at times subject to overflow, and which are fertile and very productive. At other places the river is confined between bold and abrupt banks, and in one case it flows for several miles in a very narrow channel, only 60 feet wide in places, in a deep ravine between the flanking hills, forming the noted "Narrows." Above the great bend the valley is only from 15 to 20 miles wide, and the elevations of the divides which separate the basin of the Yadkin from those adjacent are much higher, so that the tributary streams have a large fall.

The upper part of the drainage basin is rough and mountainous and largely forest covered, and throughout this part of its course the flow of the stream is more constant than would be expected.

The average rainfall over the part of the basin in North Carolina is probably between 48 and 51 inches, approximating the lower figure over the lower portions, and possibly exceeding 51 inches over the higher and more mountainous portions, the precipitation increasing as the stream is ascended. This total amount is rather evenly distributed among the seasons.

The highest flood ever known at Wilkesboro, it is stated, occurred in March, 1899, the stream at this place rising 28 feet above low water. The greatest flood recorded at the gaging station at Salisbury, N. C., occurred in December, 1901, the stream reaching an extreme height on the gage of 19.7 feet and having a probable discharge of about 130,000 second-feet, or about 38 second-feet per square mile. The flood of March, 1899, produced a rise of about 1 foot less than this flood of December. The most destructive flood ever experienced on the stream occurred in May, 1901, but the recorded gage height at the Salisbury station was less for this flood than for either of the others

mentioned, and the general testimony of those living along the banks is to the same effect.

The minimum recorded flow at the Salisbury station occurred in September, October, and November, 1897, when the basin of the stream experienced the most severe drought in its history. The flow fell to 900 second-feet several times during this period, or the basin above the station was discharging at an average rate of 0.26 second-foot per square mile. The maximum flow is thus about 144 times the minimum.

The United States Weather Bureau maintains river stations at this basin as follows:

Pedee at Cheraw, S. C.
Pedee at Smiths Mills, S. C.

During 1904 the United States Geological Survey has maintained gaging stations in this drainage basin as follows:

Yadkin at Salisbury, N. C.
Yadkin at North Wilkesboro, N. C.
Reddie at North Wilkesboro, N. C.
Mulberry, at North Wilkesboro, N. C.
Roaring at Roaring River, N. C.
Mitchell at Burch, N. C.
Fisher at Crotchfield, N. C.
Ararat at Siloam, N. C.

YADKIN RIVER NEAR SALISBURY, N. C.

This station was established by C. C. Babb, September 24, 1895, at the Southern Railway bridge about 6 miles east of Salisbury, N. C. Measurements were made from the decked railroad bridge, from which the original wire gage was also suspended. During the year 1899 the location of the measuring station and wire gage was changed to a new iron highway bridge about 300 yards above, the gage being set to read the same as the original one. Early in 1903 it was decided that the original location at the railroad bridge was better; so the station was again changed to it, but the gage was located on the plank walk supported by the lower members of the bridge. The new gage is a standard gage, and is fastened to lower member of the bridge along the plank walk, near the middle of the first span from right bank. The length of the gage chain from the end of the weight to the marker is 28.66 feet.

Bench mark No. 1 is the top of the inside eyebar of the lower chord on the downstream side, in the fourth panel from the right end of the bridge, opposite a point 80 feet from the initial point for soundings. It is marked with white paint and has an elevation of 27.28 feet above gage datum. Bench mark No. 2 is the top of the anchor-bolt head at the right downstream corner of the foot plate on the right abutment.

downstream side. Its elevation is 26.82 feet above gage datum. discharge measurements are made from the walk to which the gag attached. The bridge is a four-span iron bridge of the decked ty having a total length of about 650 feet between stone abutments, left bank abutment being at the edge of the high rocky bluff, w that at right bank is connected with the hill by a short earth emba ment. The river is confined by the abutments at all stages, and oc pies practically the whole width at low water.

The channel is straight for a long distance below, but curves c siderably above. The bed of the river is rocky, and the depth water is fairly uniform. Current is good, even at lowest stages. T initial point for soundings is the end of the bridge at right bank. T gage is read once daily by J. T. Yarbrough, the bridge keeper.

The observations at this station during 1904 have been made un the direction of M. R. Hall, district hydrographer.

Discharge measurements of Yadkin River near Salisbury, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Dischar
		Feet	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-f*
February 16	B. S. Drane	523	2,061	1.38	2.06	2,
March 17	do	522	2,132	1.44	2.19	3,
April 25	do	523	2,090	1.22	2.08	2,
July 22	do	564	1,332	1.96	1.94	2,
Do	do	528	2,128	1.38	2.22	2,
September 7	do	524	2,184	1.78	2.52	3,
September 28	do	520	1,779	.82	1.44	1,
Do	do	562	1,120	1.36	1.42	1,
December 17	do	522	1,942	1.08	1.82	2,

Measurements made at different sections.

Mean daily gage height, in feet, of Yadkin River near Salisbury, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	D
1	1.75	1.95	2.46	2.00	1.85	2.30	4.20	2.35	1.65	1.35	1.35	
2	1.85	1.74	2.35	2.05	1.95	4.65	3.05	2.25	3.10	1.25	1.35	
3	1.90	1.80	2.25	1.95	1.75	5.10	2.60	3.00	3.00	1.25	1.35	
4	1.92	1.88	2.20	2.05	1.80	3.10	2.25	2.55	2.35	1.30	1.50	
5	1.65	1.90	2.15	1.90	2.05	2.55	2.05	2.05	2.80	1.25	1.75	
6	1.30	1.85	2.00	1.85	2.10	2.30	1.85	2.40	3.15	1.30	2.10	
7	1.45	2.05	2.20	1.85	1.90	2.10	2.10	2.65	2.50	1.30	2.05	
8	1.85	3.35	a 5.20	1.95	2.20	3.00	1.90	4.85	2.15	1.35	1.60	
9	1.85	3.45	4.55	1.90	2.35	2.45	1.80	3.70	1.80	1.35	1.50	
10	1.90	2.75	3.25	2.35	2.75	2.05	2.05	3.50	1.70	1.30	1.45	
11	1.98	2.25	2.75	2.20	2.25	2.25	2.45	3.65	2.05	1.30	1.50	

a Extreme height March 8, 1904, 4 p. m. was 6 feet.

ean daily gage height, in feet, of Yadkin River near Salisbury, N. C., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2	1.85	2.15	2.50	1.90	2.25	4.20	1.95	3.80	1.80	1.30	1.50	1.85
3	1.80	2.10	2.40	1.85	2.00	3.25	1.85	3.00	1.60	1.25	1.45	1.70
4	1.85	2.04	2.40	1.80	1.85	2.30	1.80	2.45	1.65	1.30	2.70	1.70
15	1.82	2.10	2.35	1.80	2.35	2.00	1.65	2.15	1.60	1.20	2.65	1.65
16	1.78	2.00	2.25	1.80	2.35	1.90	1.85	2.80	1.60	1.10	2.05	1.65
17	1.78	1.96	2.05	1.90	1.95	1.85	1.85	3.80	1.60	1.25	1.70	1.65
18	1.90	1.80	1.95	1.95	2.00	2.60	1.85	2.90	1.50	1.20	1.60	1.70
19	1.64	1.75	1.95	1.75	6.60	2.50	1.65	2.25	1.50	1.20	1.60	1.85
20	1 70	3.00	2.10	1.75	4.25	2.50	1.55	2.00	1.50	1.30	1.50	1.70
21	1.68	2.80	2.10	1.70	2.85	2.35	1.55	2.50	1.50	1.25	1.65	1.65
22	1.68	3.95	1.95	1.70	2.40	2.10	1.70	2.85	1.50	1.30	1.50	1.60
23	1.95	5.10	2.05	1.70	2.30	2.25	2.15	2.45	1.50	1.20	1.55	1.60
24	2.60	4.20	2.30	1.70	2.00	1.90	3.55	2.30	1.50	1.20	1.60	1.65
25	2.38	3.10	4.40	1.90	1.95	1.80	2.85	2.45	1.40	1.20	1.60	1.85
26	1.95	2.55	3.30	1.75	1.85	1.65	2.25	2.50	1.45	1.30	1.55	1.95
27	1.85	2.48	2.65	2.00	1.90	1.75	2.30	1.90	1.45	1.35	1.45	2.05
28	1.92	2.70	2.70	2.30	1.85	2.05	2.55	1.95	1.40	1.35	1.55	2.65
29	1.75	2.68	2.35	2.00	1.75	4.05	3.15	1.90	1.50	1.35	1.50	2.85
30	1.60	.....	2.10	1.90	1.85	6.35	5.05	1.65	1.35	1.30	1.45	2.50
31	1.78	.....	2.05	.....	1.70	.....	3.00	1.65	.....	1.30	.....	2.05

Rating table for Yadkin River near Salisbury, N. C., from January 1, 1904, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.10	1,050	2.20	3,015	3.30	6,250	4.80	11,780
1.20	1,170	2.30	3,270	3.40	6,585	5.00	12,600
1.30	1,300	2.40	3,540	3.50	6,930	5.20	13,440
1.40	1,445	2.50	3,820	3.60	7,280	5.40	14,280
1.50	1,600	2.60	4,110	3.70	7,630	5.60	15,120
1.60	1,770	2.70	4,400	3.80	7,985	5.80	15,960
1.70	1,950	2.80	4,695	3.90	8,345	6.00	16,800
1.80	2,140	2.90	4,995	4.00	8,710	6.50	18,900
1.90	2,340	3.00	5,300	4.20	9,455		
2.00	2,550	3.10	5,610	4.40	10,220		
2.10	2,775	3.20	5,925	4.60	10,990		

The above table is applicable only for open-channel conditions. It is based upon 9 discharge measurements made during 1904 and 10 made during 1903. It is fairly well defined between gage heights 1.40 feet and 2.60 feet. The table has been extended below gage height 1.40 feet. Above gage height 5 feet the rating curve is a tangent, the difference being 420 per tenth.

Estimated monthly discharge of Yadkin River near Salisbury, N. C., for 1904.

[Drainage area, 3,399 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,110	1,300	2,226	0.655	.755
February	13,020	2,026	4,151	1.22	1.32
March	13,440	2,445	4,177	1.23	1.34
April	3,405	1,950	2,370	.697	.778
May	19,320	1,950	3,521	1.04	1.20
June	18,270	1,860	4,770	1.40	1.56
July	12,810	1,685	3,624	1.07	1.23
August	11,987	1,860	4,434	1.30	1.50
September	5,768	1,372	2,376	.699	.780
October	1,372	1,050	1,268	.373	.430
November	2,775	1,372	1,931	.568	.634
December	5,455	1,523	2,630	.774	.892
The year	19,320	1,050	2,873	.919	12.42

YADKIN RIVER AT NORTH WILKESBORO, N. C.

This station was established April 10, 1903, by E. W. Myers. It is located at the lower highway bridge between Wilkesboro and North Wilkesboro, about one-half mile below North Wilkesboro railroad station and about three-fourths of a mile below the mouth of Reddie River. The scale of the standard chain gage is fastened to the downstream guard rail with its zero 7.63 feet east of the center of the second strut from the west end of the span. The distance from the end of the weight to the marker is 33.38 feet.

Bench mark No. 1 is the top surface of the outer eyebar of the lower chord opposite a point 100 feet from the initial point for soundings. When the gage reads zero the water surface is 30.75 feet below this bench mark. Bench mark No. 2 is the top corner of the pulley frame above the hole in the box which incloses the chain. When the gage reads zero the water surface is 31.88 feet below this bench mark.

Discharge measurements are made from the downstream side of the steel highway bridge to which the gage is attached. The bridge consists of a single steel span about 125 feet long, under which the river flows at ordinary stages, and three wooden spans about 50 feet each on the right bank. There are also wooden trestle approaches about 170 feet long on the right bank and about 40 feet on the left

bank. The initial point for soundings is the end of the downstream guard rail at the left end of the bridge. Distances are measured along this guard rail and are marked in white paint. The channel is straight above the station, but makes a very slight curve beneath the bridge. Below the station the channel is straight for about 600 feet. The water is swift both above and below. The right bank is low and is subject to overflow, but all water must pass beneath the bridge and its approaches. The left bank is high and rocky and does not overflow at the bridge. Above the bridge it (the left bank) is subject to overflow. The bed of the stream is rocky, with sand in places. There is a single channel at all stages. The gage was read once each day during 1904 by U. H. Wyatt.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Yadkin River at North Wilkesboro, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 11	B. S. Drane	95	434	2.30	1.17	1,000
March 12	do	95	399	2.26	.92	903
April 18	do	93	308	1.87	.31	574
April 19	do	93	306	1.88	.26	575
June 8	do	96	396	2.54	1.24	1,004
Do	do	96	396	2.55	1.22	1,009
September 22	do	93	218	2.13	.09	465
Do	do	93	218	1.96	.09	428
December 21	do	92	229	2.13	.07	452
Do	do	92	226	2.06	.03	432

Mean daily gage height, in feet, of Yadkin River at North Wilkesboro, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.30	[a]0.40	0.85	0.60	0.20	4.60	2.50	1.25	0.50	0.00	−0.05	0.05
2	.30	−[b].20	.80	.50	.20	2.70	1.25	1.20	.70	.00	−.05	−.05
3	.30	[a].40	.70	.45	1.30	1.75	.90	1.35	.45	.00	−.05	.20
4	−[b].05	[b].20	.65	.40	2.20	1.40	.75	.70	.40	−.05	.25	.10
5	−[b].05	[b].20	.50	.35	1.10	1.10	1.00	.95	2.40	.05	1.30	.10
6	.10	[a].50	.40	.30	.90	2.15	1.15	1.50	.85	.00	.25	1.30
7	.40	.50	7.50	.50	.90	1.45	.80	.75	.60	.00	.00	.40
8	.20	1.95	3.70	.50	1.10	1.50	1.35	2.25	.50	.00	.00	.20
9	.20	.85	2.10	1.05	2.90	.95	.70	1.20	.45	−.05	.00	.10
10	.25	.60	1.50	.55	2.20	.95	1.20	2.15	.40	−.10	.00	.10
11	.25	.55	1.20	.50	1.60	1.50	.70	1.60	.40	−.10	−.05	.10
12	.30	.45	.90	.40	1.20	1.10	.85	1.20	.45	−.10	.05	.05
13	.30	.30	.75	.35	.95	.85	.55	.95	.40	−.10	.60	.00

[a] Thaw. [b] Freeze.

Mean daily gage height, in feet, of Yadkin River at North Wilkesboro, N. C., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
14	.30	.40	.80	.30	.75	.70	.40	.90	.55	− .10	.75	− .10
15	a .00	.35	.70	.25	.90	.65	.40	1.70	.30	− .10	.20	.00
16	b .20	.30	.55	.20	.60	.65	.40	1.60	.20	− .10	.10	.00
17	.25	.10	.50	.25	.50	1.95	.60	.75	.20	− .10	.00	.10
18	.05	.30	.50	.25	9.80	.90	.35	.50	.10	− .10	.00	.10
19	−a .05	.30	.50	.25	8.40	.90	.25	.40	.10	− .10	.00	− .10
20	− .20	.45	.45	.20	2.00	1.00	.20	1.05	.10	− .10	.00	− .10
21	b .30	.30	.55	.20	1.40	.75	.20	1.20	.10	− .10	.00	.10
22	.35	2.35	.80	.20	1.10	.70	.20	1.25	.10	− .10	.00	− .05
23	.20	1.90	.65	.20	.90	.50	.20	.75	.00	− .15	.00	− .05
24	.90	1.15	1.60	.20	.75	.45	.30	4.50	.00	− .15	.00	.00
25	.60	.80	1.25	.20	.90	.40	1.60	1.40	.00	− .15	− .10	.10
26	.50	.70	1.00	.65	.90	.50	1.20	1.05	10	− .15	− .10	.05
27	.35	.80	1.10	.65	.60	.55	.45	.80	.10	− .05	− .10	.30
28	.35	.90	.85	.40	.50	4.80	.95	.65	.05	− .05	− .10	1.70
29	a .25	.90	.70	.30	.40	2.50	6.70	.60	.05	− .05	− .10	.60
30	a .10	.....	.60	.25	.80	1.65	1.35	.50	.00	− .05	− .05	.15
31	a .10	.....	.60	.....	1.70	.....	.85	.45	.....	− .05	.....	.25

a Freeze. b Thaw.

Rating table for Yadkin River at North Wilkesboro, N. C., from January 1, 1904, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.00	417	.60	710	1.20	1,010	1.80	1,345
.10	465	.70	760	1.30	1,060	1.90	1,410
.20	513	.80	810	1.40	1,115	2.00	1,475
.30	562	.90	860	1.50	1,170		
.40	611	1.00	910	1.60	1,225		
.50	660	1.10	960	1.70	1,285		

The above table is applicable only for open-channel conditions. It is based upon 10 discharge measurements made during 1904. It is well defined between gage heights 0 feet and 1.30 feet. The table has been extended beyond these limits. Above gage height 2 feet the discharge has been estimated.

Estimated monthly discharge of Yadkin River at North Wilkesboro, N. C., for 1904.

[Drainage area 498 square miles.]

Room.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	860	322	532	1.07	1.23
February	1,730	322	742	1.49	1.61
March	9,300	611	1,171	2.35	2.71
April	935	513	602	1.21	1.35
May	14,500	513	1,467	2.95	3.40
June	4,375	611	1,224	2.46	2.74
July	7,650	513	1,032	2.07	2.39
August	3,950	611	1,059	2.13	2.46
September	1,770	417	594	1.19	1.33
October	417	345	381	.765	.882
November	1,060	369	461	.926	1.03
December	1,285	369	506	1.02	1.18
The year	14,500	322	814	1.64	22.31

REDDIE RIVER AT NORTH WILKESBORO, N. C.

This station was established as a bench-mark station April 18, 1904, by B. S. Drane. It is located at the highway bridge just without the town of North Wilkesboro, N. C., and about one-half mile above the mouth of Reddie River. Discharge measurements are made from the downstream side of the single-span, covered, bridge, the meter being lowered outside the floor. The initial point for soundings is the left end of the bottom rail downstream hand rail. The channel is straight for about 500 feet above and below the station. The current is swift. Both banks are high and not subject to overflow. The bed of the stream is composed of sand, and is somewhat shifting. There is only one channel for all stages. A small lumber mill and dam a short distance above the station will affect the flow during low water. The bench mark is the upper edge of the lower rail of the downstream guard rail, by the side of a notch, 66 feet from the initial point for soundings. Its elevation is 27 feet above datum.

Discharge measurements of Reddie River at North Wilkesboro, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 18	B. S. Drane	57	61	1.22	1.98	75
June 9	do	59	91	1.69	2.26	153
September 23	do	50	51	1.57	1.66	80

MULBERRY RIVER NEAR NORTH WILKESBORO, N. C.

This station was established as a bench-mark station November 7, 1903, by B. S. Drane. It is located at the Southern Railway bridge about 2 miles east of North Wilkesboro, N. C., and less than one-half mile above the mouth of Mulberry River. Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the streamward face of the left trestle bent. The channel is curved for 100 feet above and below the station. The current is swift. The right-bank approach is over a long trestle and the stream overflows under this during high stages. The left bank is rocky and the section is bounded by the masonry abutment of the railroad fill. The bed of the stream is rocky along the left bank, sandy along the right bank, and is permanent. There is but one channel. The current is broken at all but the lowest stages by one or more of the trestle bents supporting the bridge. High water in Yadkin River will probably back up to this point. The bench mark is the apex of the triangular downstream end of the iron bearing through which pass the iron tension rods midway between the ends of the truss, on the downstream side of the bridge, about 2 feet east of the second bent from the left bank. Its elevation is 24 feet above datum.

Discharge measurements of Mulberry River near North Wilkesboro, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 19	B. S. Drane	15	25	1.62	1.12	41
June 8	do	25	31	1.98	1.30	61
September 22	do	21	21	1.37	.91	29

ROARING RIVER AT ROARING RIVER, N. C.

This station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located at the Southern Railway bridge, a short distance above the mouth of Roaring River, at Roaring River, N.

Discharge measurements are made from the downstream side of the one-span bridge. The initial point for soundings is on the downstream guard-rail, exactly over the left end of the bridge. The channel is straight for about 200 feet above and 500 feet below the station. The current is swift. The banks rise gradually, but all water passes beneath the bridge and its approaches. The bed of the stream is composed of sand and gravel and is slightly shifting. There is but one channel at all stages, broken during high water by the piers and trestle approaches of the bridge. High water in Yadkin River will make this site of no value as a gaging station, but it is good at ordinary stages. The bridge crosses the river almost at right angles to the current. The bench mark is the edge of the outermost eyebar of the downstream lower chord, at a point midway between the ends of the bridge opposite the iron tension rods. Its elevation is 27 feet above gage datum.

Discharge measurements of Roaring River at Roaring River, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 20	B. S. Drane	62	103	1.20	1.55	125
June 9	do	78	105	1.70	1.93	178
September 23	do	63	53	1.36	1.10	72

MITCHELL RIVER AT BURCH, N. C.

This station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located at the Southern Railway bridge at Burch, N. C., a few hundred feet above the mouth of Mitchells River. Discharge measurements are made from the downstream side of the one-span railway bridge. The initial point for soundings is the end of the downstream guard-rail at the left end of the bridge. The channel is straight for about 700 feet above and 300 feet below the station. Both banks are high, clean, and not liable to overflow. The bed of the stream is composed of sand and gravel, and is slightly shifting. There is but one channel at all stages. Good measurements can be made at ordinary stages, but high water in Yadkin River renders the station of no value as a gaging point. The bridge crosses the stream diagonally. The bench mark is the upper edge of the outermost eyebar of the lower chord, downstream side, midway between the ends of the bridge, 62.5 feet from the initial point for soundings. Its elevation is 27 feet above datum.

Discharge measurements of Mitchell River at Burch, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 20	B. S. Drane	84.5	169	.57	2.07	96
September 23	do	65	150	.46	1.99	69

FISHER RIVER NEAR CRUTCHFIELD, N. C.

This station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located about 2 miles east of Crutchfield, N. C., at the Southern Railway bridge, just above the mouth of the river. Discharge measurements are made from the upstream side of the one-span bridge. The initial point for soundings is the right end of the upstream guard rail. The channel is curved for about 500 feet above and 100 feet below the station. The current is very sluggish. Both banks are high, and not liable to overflow. The bed of the stream is composed of deep mud and silt, and is obstructed along the right bank by the ironwork of an old bridge burned here. There is but one channel for all stages.

High water in Yadkin River will make the station valueless at such times, and the station has little to recommend it except its accessibility. Bench mark No. 1 is the upstream edge of the upper surface of the I beam forming the upstream lower chord, at a point 90 feet from the initial point for soundings. Its elevation is 27 feet above datum. Bench mark No. 2 is the upper edge of the head of a large wire nail driven into a triangular-shaped blaze in the downstream face of a large willow tree on the left bank, 100 yards above the bridge. Its elevation is 12.15 feet above gage datum.

Discharge measurements of Fisher River near Crutchfield, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 20	B. S. Drane	87	265	0.59	1.40	156
September 24	do	103	320	.25	1.06	80

ARARAT RIVER NEAR SILOAM, N. C.

This station was established as a bench-mark station April 21, 1904 by B. S. Drane. It is located at the Southern Railway bridge about mile east of Siloam, N. C., and a short distance above the mouth the river. Discharge measurements are made from the downstrea

side of the single-span bridge, having a short trestle approach at each end. The initial point for soundings is a point on the downstream guard rail at the left end of the truss. The channel is straight for about 500 feet above and 150 feet below the station. The current is swift. Both banks slope gradually. All water passes beneath the bridge and approaches. The bed of the stream is composed of sand, free from vegetation, and somewhat shifting. There is but one channel at all stages. Flood stages will flow around the cribwork pier on each bank, supporting the ends of the iron bridge.

High water in Yadkin River will make this valueless as a gaging site, but it is a good point for low-water measurements. The bridge crosses the stream almost at right angles. The bench mark is the surface of the outer eyebar of the lower chord of the bridge, downstream side, exactly midway between the ends of the bridge, just outside the iron tension rods. Its elevation is 28 feet above gage datum.

Discharge measurements of Ararat River near Siloam, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 21	B. S. Drane	111	169	1.64	1.08	277
June 9	do	114	217	1.41	1.63	306
September 24	do	111	210	.81	.80	170

MISCELLANEOUS DISCHARGE MEASUREMENTS IN THE YADKIN BASIN.

The following is a list of miscellaneous discharge measurements made in the Yadkin River drainage basin during 1904:

Yadkin River at Crutchfield, N. C.—A gaging made from the ferry April 21 gave the following results: Width, 227 feet; area, 690 square feet; mean velocity, 1.48 feet per second; discharge, 1.023 second-feet. No bench marks were established, but the gage at Salisbury showed a uniform stage of 1.70 feet gage height from April 21 to 24.

Elkin Creek at Elkin, N. C.—This stream enters Yadkin River from the north at the town of Elkin, N. C. Gagings have been made from the Southern Railway bridge, just above the mouth of the creek, as follows: April 19—width, 26 feet; area, 68 square feet; mean velocity, 0.36 foot per second; gage height, 0.80 foot; discharge, 24 second-feet. June 9—width, 26 feet; area, 59 square feet; mean velocity, 0.46 foot per second; gage height, 1.14 feet; discharge, 27 second-feet. The bench mark is the top of the outer eyebar of the downstream lower chord on the right side of the second strut from the left end of the bridge. Its elevation is 25 feet above the datum of the gage.

INDEX.

	Page.
ɛtam Creek near—	
Sharpsburg, Md.:	
description	67-68
discharge	68
discharge, monthly	69
gage heights	68
rating table	69
mattox River at—	
Mattoax, Va.:	
description	91-92
discharge	92
discharge, monthly	94
gage heights	92
rating table	93
ıt River at—	
Siloam, N. C.:	
description	118-119
discharge	119
ıter River at—	
Houston, Va.:	
description	106-107
discharge	107
gage heights	107
r, Md.	
Little Gunpowder Falls near:	
description	57
discharge	58
ıamton, N. Y.	
Chenango River at:	
description	18-19
discharge	19
discharge, daily	21
discharge, monthly	22
gage heights	19-20
rating table	20
usquehanna River at:	
description	18-19
discharge	19
discharge, daily	21
discharge, monthly	22
gage heights	19-20
rating table	20
l Creek at—	
Hill Green, Md.:	
description	55-56
ıman, Va.	
James River at:	
description	81
discharge	82
Buchanan, Va.—Continued.	
James River at—Continued.	
discharge, monthly	83
gage heights	82
rating table	83
Burch, N. C.	
Mitchell River at:	
description	117
discharge	118
Cartersville, Va.	
James River at:	
description	85
discharge	85
discharge, monthly	88
gage heights	86
rating table	87
Chemung, N. Y.	
Chemung River at:	
description	43-44
discharge	44
discharge, daily	46-47
discharge, monthly	48
gage heights	44-45
rating table	46
Chemung River at—	
Chemung, N. Y.:	
description	43-44
discharge	44
discharge, daily	46-47
discharge, monthly	48
gage heights	44-45
rating table	46
Chenango River at—	
Binghamton, N. Y.:	
description	39
discharge	40
discharge, daily	41-42
discharge, monthly	42
gage heights	40
rating table	41
Churchville, Md.	
Deer Creek at:	
description	56
discharge	56
Crutchfield, N. C.	
Fisher River at:	
description	118
discharge	118
Yadkin River at:	
discharge	119

Dan River at— Page.
Madison, N. C.:
description 100-101
discharge 101
discharge, monthly 102-103
gage heights 101-102
rating table 102
South Boston, Va.:
description 103-104
discharge 104
discharge, monthly 105
gage heights 104
rating table 105
Danville, Pa.
North Branch of Susquehanna River at:
description 27-28
gage heights 28
Deer Creek at—
Churchville, Md.:
description 56
discharge 56
Elkin, N. C.
Elkin Creek at:
description 119
discharge 119
Elkin Creek at—
Elkin, N. C.:
description 119
discharge 119
Fisher River at—
Crutchfield, N. C.:
description 118
discharge 118
Frederick, Md.
Monocacy River near:
description 76-77
discharge 77
discharge, monthly 79
gage heights 77-78
rating table 78
Front Royal, Va.
South Branch of Shenandoah River near:
description 72-73
discharge 73
discharge, monthly 74
gage heights 73
rating table 74
Glasgow, Va.
James River at:
description 88-89
discharge 89
discharge, monthly 91
gage heights 89-90
rating table 90
Glencoe, Md.
Gunpowder Falls near:
description 57
Gunpowder Falls near—
Glencoe:
description 57
Gunpowder River drainage basin:
description 56-57
Harrisburg, Pa.
Susquehanna River at:
description 29-30
Harrisburg, Pa.—Continued. Page.
Susquehanna River at—Cont'd.
discharge 30-31
discharge, monthly 33
gage heights 31
rating table 32
Holcomb Rock, Va.
James River at:
description 84
gage heights 84
Houston, Va.
Banister River at:
description 106-107
discharge 107
gage heights 107
James River at—
Buchanan, Va.:
description 81
discharge 82
discharge, monthly 83
gage heights 82
rating table 83
Cartersville, Va.:
description 85
discharge 86
discharge, monthly 86
gage heights 86
rating table 87
Holcomb Rock, Va.:
description 84
gage heights 84
James River, North Fork, at—
Glasgow, Va.:
description 88-89
discharge 89
discharge, monthly 91
gage heights 89-90
rating table 90
James River drainage basin:
description 79-80
gaging stations 82-8
Juniata River at—
Newport, Pa.:
description
discharge
discharge, daily 7-4
discharge, monthly
gage heights
rating table
McCall Ferry, Pa.
Susquehanna River at:
description 3-
discharge
discharge, daily 37
discharge, monthly
gage heights
rating table
Little Gunpowder Falls near—
Belair, Md.:
description
discharge
Madison, N. C.
Dan River at:
description 100
discharge
discharge, monthly 102

son, N. C.—Continued. Page.
Dan River at—Continued.
gage heights 101–102
rating table 102
Mayo River at:
description 106
discharge 106
oax, Va.
Appomattox River at:
description 91–92
discharge 92
discharge, monthly 94
gage heights 92
rating table 93
River at—
Madison, N. C.:
description 106
discharge 106
Green, Md.
Broad Creek at:
description 55–56
ille, W. Va.
Shenandoah River at:
description 69–70
discharge 70
discharge, monthly 72
gage heights 70–71
rating table 71
ell River at—
Bunch, N. C.:
description 117
discharge 118
cacy River near—
Frederick, Md.:
description 76–77
discharge 77
discharge, monthly 79
gage heights 77–78
rating table 78
erry River at—
North Wilkesboro, N. C.:
description 116
discharge 116
ort, Pa.
Juniata River at:
description 52
discharge 52
discharge, daily 54–55
discharge, monthly 55
gage heights 53
rating table 54
Wilkesboro, N. C.
Mulberry River near:
description 116
discharge 116
Reddie River at:
description 115
discharge 116
Yadkin River at:
description 112–113
discharge 113
discharge, monthly 115
gage heights 113–114
rating table 114
Patapsco River at— Page.
Woodstock, Md.:
description 58–59
discharge 59
gage heights 59–60
Patapsco River drainage basin:
description 58
Piedmont, W. Va.
North Branch of Potomac River at:
description 61–62
discharge 62
gage heights 62
Point of Rocks, Md.
Potomac River at:
description 63
discharge 64
discharge, monthly 65
gage heights 64
rating table 65
Potomac River at—
Point of Rocks, Md.:
description 63
discharge 64
discharge, monthly 65
gage heights 64
rating table 65
Potomac River, North Branch of, at—
Piedmont, W. Va.:
description 61–62
discharge 62
gage heights 62
Potomac River, South Branch of, near—
Springfield, W. Va.:
description 66
discharge 66
gage heights 67
Potomac River drainage basin:
description 60–61
gaging stations 61
Randolph, Va.
Staunton River at:
description 98
discharge 98
discharge, monthly 100
gage heights 98–99
rating table 99
Reddie River at—
North Wilkesboro, N. C.:
description 115
discharge 116
Riverton, Va.
North Branch of Shenandoah River near:
description 75
discharge 75
gage heights 76
Roanoke, Va.
Roanoke River at:
description 95
discharge 96
discharge, monthly 97
gage heights 96
rating table 97

Page.

Roanoke River at—
Roanoke, Va.:
description 95
discharge 96
discharge, monthly 97
gage heights 96
rating table 97
Roanoke River drainage basin:
gaging stations 95
description 94–95
Roaring River, N. C.
Roaring River at:
description 116–117
discharge 117
Roaring River at—
Roaring River, N. C.:
description 116–117
discharge 117
Salisbury, N. C.
Yadkin River near:
description 109–110
discharge 110
discharge, monthly 112
gage heights 110–111
rating table 111
Sharpsburg, Md.
Antietam Creek near:
description 67–68
discharge 68
discharge, monthly 69
gage heights 68
rating table 69
Shenandoah River at—
Millville, W. Va.:
description 69–70
discharge 70
discharge, monthly 72
gage heights 70–71
rating table 71
Shenandoah River, North Branch of, near—
Riverton, Va.:
description 75
discharge 75
gage heights 76
Shenandoah River, South Branch of, near—
Front Royal, Va.:
description 72–73
discharge 73
discharge, monthly 74
gage heights 73
rating table 74
Siloam, N. C.
Ararat River at:
description 118–119
discharge 119
South Boston, Va.
Dan River at:
description 103–104
discharge 104
discharge, monthly 105
gage heights 104
rating table 105
Springfield, W. Va.
South Branch of Potomac River near:
description
discharge
gage heights
Staunton River at—
Randolph, Va.:
description
discharge
discharge, monthly
gage heights
rating table
Susquehanna River at—
Binghamton, N. Y.:
description
discharge
discharge, daily
discharge, monthly
gage heights
rating table
Harrisburg, Pa.:
description
discharge
discharge, daily
discharge, monthly
gage heights
rating table
McCall Ferry, Pa.:
description
discharge
discharge, daily
discharge, monthly
gage heights
rating table
Wilkesbarre, Pa.:
description
discharge
discharge, daily
discharge, monthly
gage heights
rating table
Susquehanna River, North Branch, at—
Danville, Pa.:
description
gage heights
Susquehanna River, West Branch, at—
Williamsport, Pa.:
description
discharge
discharge, daily
discharge, monthly
gage heights
rating table
Susquehanna River drainage basin:
description
gaging stations
Wilkesbarre, Pa.
Susquehanna River at:
description
discharge

	Page.
sbarre, Pa.—Continued.	
Susquehanna River at—Cont'd.	
discharge, daily	26
discharge, monthly	27
gage heights	24
rating table	25
ımsport, Pa.	
West Branch of Susquehanna River at:	
description	48–49
discharge	49
discharge, daily	50–51
discharge, monthly	51
gage heights	49
rating table	50
lstock, Md.	
Patapsco River at:	
description	58–59
discharge	59
gage heights	59–60
Yadkin River at—	
Crutchfield, N. C.:	
discharge	119
North Wilkesboro, N. C.:	
description	112–113
discharge	113
discharge, monthly	115
gage heights	113–114
rating table	114
Salisbury, N. C.:	
description	109–110
discharge	110
discharge, monthly	112
gage heights	110–111
rating table	111
Yadkin (Pedee) River drainage basin:	
description	107–109
discharge	119
gaging stations	109

O

[redacted]

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 126.]

publications of the United States Geological Survey consist of (1) Annual Reports; (2) Mono-
s; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Supply and Irrigation
s; (7) Topographic Atlas of United States, folios and separate sheets thereof; (8) Geologic Atlas
ited States, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the
are distributed free. A circular giving complete lists may be had on application.

Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of subjects, and
tal number issued is large. They have therefore been classified into the following series: A,
omic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography
ineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irriga-
J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investi-
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limited number are delivered to the Director of the Survey, from whom they may be obtained,
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rge, on application.

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ay be had at practically cost.

pies of all Government publications are furnished to the principal public libraries in the large
hroughout the United States, where they may be consulted by those interested.

s P.—The hydrographic progress reports contain the results of stream measurements. A
is issued for every calendar year, containing the results of data collected during that year.
reports were first published as a part of the Director's annual report or as a bulletin; they are
blished as water-supply and irrigation papers. The following is a list, by years, of the publica-
ontaining the progress reports of stream measurements. A detailed index of these reports is
ed as Water-Supply Paper No. 119.

8. Tenth Annual Report, Part II.
9. Eleventh Annual Report, Part II.
0. Twelfth Annual Report, Part II.
1. Thirteenth Annual Report, Part III.
2. Fourteenth Annual Report, Part II.
3. Bulletin No. 131.
4. Bulletin No. 131; Sixteenth Annual Report, Part II.
5. Bulletin No. 140.
6. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
7. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
8. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
9. Water-Supply Papers Nos. 35, 36, 37, 38, and 39; Twenty-first Annual Report, Part IV.
0. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV.
1. East of the Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of the Mississippi River, Water-Supply Papers Nos. 66 and 75.
2. East of the Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of the Mississippi River, Water-Supply Papers Nos. 84 and 85.
3. East of the Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of the Mississippi River, Water-Supply Papers Nos. 99 and 100.
4. East of the Mississippi River, Water-Supply Papers Nos. 124, 125, 126, 127, 128, and 129.
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THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

ter-Supply and Irrigation Paper No. 127 Series P, Hydrographic Progress Reports, 32

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

OGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

BY

M. R. HALL and JOHN C. HOYT

' IV.—Santee, Savannah, Ogeechee, and Altamaha Rivers and Eastern Gulf of Mexico Drainages

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

Apalachicola River drainage basin—Continued. Page.
Mulberry Creek near Columbus, Ga 10
Flint River near Woodbury, Ga 10
Flint River at Albany, Ga 10
Big Potato Creek near Thomaston, Ga 1
Muckalee Creek near Albany, Ga 1
Kinchafoonee Creek near Albany, Ga 1
Miscellaneous measurements .....
Choctawhatchee River drainage basin .....
Choctawhatchee River near Geneva, Ala .....
Double Bridges Creek at Geneva, Ala .....
Pea River at Pera, Ala .....
Escambia River drainage basin .....
Conecuh River at Beck, Ala .....
Mobile River drainage basin .....
Alabama River at Selma, Ala .....
Etowah River at Canton, Ga .....
Etowah River near Rome, Ga .....
Coosa River at Riverside, Ala .....
Oostanaula River at Resaca, Ga .....
Coosawatee River at Carters, Ga .....
Cartecay River near Cartecay, Ga .....
Ellijay River near Ellijay, Ga .....
Mountaintown Creek near Ellijay, Ga .....
Talking Rock Creek near Carters, Ga .....
Choccolocco Creek near Jenifer, Ala .....
Talladega Creek at Nottingham, Ala .....
Tallapoosa River at Buchanan Bridge, near Tallapoosa, Ga .....
Tallapoosa River at Adderhold Bridge, near Tallapoosa, Ga .....
Tallapoosa River near Heflin, Ala .....
Tallapoosa River at Sturdevant, Ala .....
Little Tallapoosa River 3 miles north of Wedowee, Ala .....
Little Tallapoosa River 6 miles northwest of Wedowee, Ala .....
Cahaba River at Centerville, Ala .....
Tombigbee River at Columbus, Miss .....
Black Warrior River near Cordova, Ala .....
Black Warrior River at Tuscaloosa, Ala .....
Clear Creek near Elk, Ala .....
Black Water Creek near Jasper, Ala .....
Black Warrior River (Locust Fork) at Palos, Ala .....
Miscellaneous measurements .....
Pearl River drainage basin .....
Pearl River at Jackson, Miss .....
Minor Eastern Gulf of Mexico drainage basins .....
Miscellaneous measurements .....
Index .....

ILLUSTRATIONS.

PLATE I. Map showing location of principal gaging stations in the United States .....
II. Price current meters, with buzzers .....
FIG. 1. Cable station, showing section of the river, car, gage, etc .....

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., April 4, 1905.

SIR: I transmit herewith the manuscript of Part IV of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of the Mississippi.

The larger part of the original data for this report was collected under the direction of District Hydrographer M. R. Hall, who was assisted by W. E. Hall, J. M. Giles, and B. S. Drane. The assembling of the data and its preparation for publication were done under the direction of John C. Hoyt, who has been assisted by R. H. Bolster, Robert Follansbee, Willis E. Hall, A. H. Horton, H. D. Comstock, and H. M. Morse.

I request that this manuscript be published as one of the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

ROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART IV.

By M. R. HALL and JOHN C. HOYT.

INTRODUCTION.

The hydrographic work of the United States Geological Survey ıcludes the collection of facts concerning and the study of conditions fecting the behavior of water from the time it reaches the earth as ıin or snow until it joins the oceans or great navigable rivers. These ıvestigations became a distinct feature of the work of the Survey in ıe fall of 1888, when an instruction camp was established at Embudo, Mex. Since that date the work has been continually and gradually tended as larger funds became available. The first distinctive appro-ıiation for gaging streams was made by the act of August 18, 1894, ıich contained an item of $12,500, "for gaging the streams and termining the water supply of the United States, including the vestigation of underground currents and artesian wells in the arid d semiarid sections." (Digest of Appropriations for 1895, p. 270.) Since that time a similar act has been passed each year and the propriations have gradually increased, as shown in the following ıle:

Annual appropriations for hydrographic surveys.

ar ending June 30, 1895	$12,500
ar ending June 30, 1896	25,000
ar ending June 30, 1897	50,000
ar ending June 30, 1898	50,000
ar ending June 30, 1899	50,000
ar ending June 30, 1900	50,000
ar ending June 30, 1901	100,000
ar ending June 30, 1902	100,000
ar ending June 30, 1903	200,000
ar ending June 30, 1904	200,000
ar ending June 30, 1905	200,000
ar ending June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the stematic study of the flow of the surface waters and the conditions

affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observation.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations, and, second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is swift some appliance, generally a secondary cable, is necessary to hold the meter below the surface.

MAP (NED DURING 1904.

aging stations are generally located at bridges, if the channel con-
ons are satisfactory, as from them the meter can be easily manipu-
l and the cost of the equipment is comparatively small. The
ons are located as far as possible at points where the channel is
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no cross currents, backwater, or boils. The bed of the stream
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character. The banks should be high, and should overflow at
stages only. At stations with shifting beds more measurements
made, and special methods of computing daily discharges are
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and using a weir formula. On the smaller streams sharp-crested
s are in some cases erected.

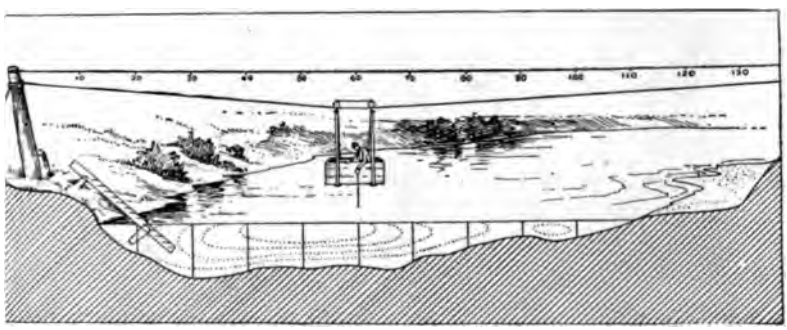

FIG. 1.—Cable station, showing section of river, car, gage, etc.

e principal instrument used in stream-measurement work is the
ent meter, by which the velocity of the flow of water is deter-
d. After years of experience the Survey has adopted the Price
ent meter for general work. This meter, as is shown on Pl. II, is
e in two sizes, known as the large and small Price. The small
e has been largely developed by the officers of the Survey, using
Price acoustic meter as a basis.

discharge measurement is the determination of the quantity of
r flowing past a certain point at a given time. This quantity is
product of two factors: (1) The mean velocity, which is the func-
of the cross section, surface, slope, wetted perimeter, and rough-
of bed; (2) the area, which depends upon the permanency of the
and the fluctuations of the surface, which govern the depth.

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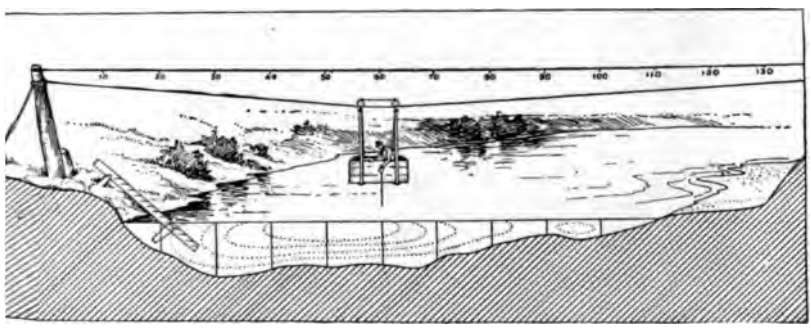

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perpendicular to the thread of the stream (see fig. 1). These points
usually at regular intervals varying from 2 to 20 feet, depending

upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenths depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at sixth-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between 0.94 and 1.04, with a mean for the 910 observations of 1.00. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from 0.85 to 0.95, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By platting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth into the area bounded by this mean velocity curve and the initial line. Owing to the length of time it takes to make these measurements, they are seldom used except for determining coefficients for purposes of comparison and for measurements under ice.

PRICE CURRENT METERS, WITH BUZZERS.

The "acre-foot" is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot: 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area, on the assumption that the run-off is uniformly distributed.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow per second.

The base data for computing the daily discharge of a stream are the daily gage heights and the various discharge measurements, of which there should be sufficient number to cover the range of stage. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights. (2 and 3 depend on 1.)

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent, or practically permanent, beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissæ. Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. Aside from plotting the discharge, the mean velocity and area determined for each discharge measurement are plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mea

locity and the area at various stages as determined by these curves. ese curves of mean velocity and area are of special value to determine e location of the rating curve for stages at which actual discharge easurements are not available and for extending the discharge curve utside the limits of the measurements. In the preparation of the rating ble the discharge for each tenth or half tenth on the gage is found om the curve. The first and second differences of these discharges e then taken and adjusted according to the law that they shall either e constant or increasing, never decreasing. The discharges in the ble are then changed in accordance with these adjusted differences. n making up the station-rating curve the individual discharge measrements and the conditions under which they were taken are carefully udied, in order that proper weight shall be given to each measureent. Rating curves in general take the form of a parabola, and as a le the high-water portion of the curve approaches a straight line. or stations of permanent character the results of the measurements om year to year should be within 5 per cent of the curve, with the ception of those taken during high water, when the probable error ay be as high as 10 per cent.

The determination of the daily discharge of streams with changeble beds is difficult, and unless frequent discharge measurements e made the results obtained are only roughly approximate. For reams with continually shifting beds, such as Colorado River and the io Grande, discharge measurements are made every two or three ys, and the discharges for the intervening days are obtained by terpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed uring floods, station-rating curves and tables can be prepared for the eriods between changes, and satisfactory results can be obtained with vo or three measurements a month, providing measurements are ken soon after the changes take place.

In determining the flow for periods when the streams are frozen, ecial rating curves and tables have to be prepared from measureents taken under these conditions. The methods of constructing ese curves and tables are the same as for open sections. The disarge measurements, however, are either taken by integration in rticals or by the vertical velocity-curve method, as sufficient experients have not been made on ice-covered streams to determine the vs which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar ar 1904, of which this is Part IV, is published in a series of twelve ater-Supply Papers, Nos. 124–135, inclusive, under the following titles:

Part 1. Atlantic coast of New England drainage.

Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.

Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.

Part 4. Santee, Savannah, Ogeechee, and Altamaha rivers and Eastern Gulf of Mexico drainage.

Part 5. Eastern Mississippi River drainage.

Part 6. Great Lakes and St. Lawrence River drainage.

Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.

Part 8. Platte, Kansas, Meremac, Arkansas, and Red River drainages.

Part 9. Western Gulf of Mexico drainage.

Part 10. Colorado River and Great Basin drainage.

Part 11. The Great Basin and Pacific Ocean drainage in California.

Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations and such other information that has been collected that has a direct bearing on these data including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage heights gives for each day the mean height of the surface of the river as found from the mean of the gage readings taken on that day. At most of the stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated run-off the column headed "Maximum" gives the mean flow for the day when the mean gage height was the

ghest, and it is the flow as given in the rating table for that mean ge height. As the gage height is the mean for the day, there might ve been short periods when the water was higher and the corre-onding discharge larger than given in this column. Likewise in the lumn of "Minimum" the quantity given is the mean flow for the ay when the mean gage height was lowest. The column headed Mean" gives the average flow for each second during the month. pon this mean the computations for the three remaining columns hich are defined on pages 11 and 12 are based.

In the computations for the tables of this report the following gen-ral and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and oney is imperative.

2. All items of computation should in general be expressed by at least two and by ot more than four significant figures.

3. Any measurement in a vertical velocity, mean velocity, or discharge curve hose per cent of error is 5 times the average per cent error of all the other meas-rements should be rejected.

4. In reducing the number of significant figures, or the number of decimal places, y dropping the last figure, the following rules apply:

(a) When the figure in the place to be rejected is less than 5, drop it without hanging the preceding figure. Example: 1,827.4 becomes 1,827.

(b) When the figure in the place to be rejected is greater than 5, drop it and icrease the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(c) When the figure in the place to be rejected is 5, and it is preceded by an even gure, drop the 5. Example: 1,828.5 becomes 1,828.

(d) When the figure in the place to be rejected is 5, and it is preceded by an odd gure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 ecomes 1,828.

5. In constructing and applying rating tables a maximum limit of one-half per ent error should seldom be exceeded.

Special rules for computation.

1. Rating tables are to be constructed as close as the data upon which they are sed will warrant. No decimals are to be used when the discharge is over 50 cond-feet.

2. Daily discharges shall be applied directly to the gage heights as they are bulated.

3. Monthly means are to be carried out to one decimal place when the quantities e below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in e monthly mean shall be a significant figure. This also applies to the yearly ean.

4. Second-feet per square mile and depth in inches for the individual months shall carried out at least to three significant figures, except in the case of decimals, here the first significant figure is preceded by one or more "0," when the quantity all be carried out to two significant figures. Example: 1.25; .125; .012; .0012. he yearly means for these quantities are always to be expressed in three significant gures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of the reports for years previous to 1904 is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive.
West of Mississippi River, Water-Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at prices slightly above cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the names of the resident hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

labama.—District hydrographer, M. R. Hall,[a] assisted by J. M. Giles, W. E. Hall, B. S. Drane. Dr. E. A. Smith, State geologist, has paid the salaries of river ervers at Beck, Pera, Sturdevant, Jenifer, Riverside, Nottingham, Elk, and Cenille. Gage heights were furnished by the Corps of Engineers, U. S. Army, for s, Cordova, and Tuscaloosa, and by the United States Weather Bureau observer, . Chaffee, for Selma and Montgomery.

eorgia.—District hydrographer, M. R. Hall, assisted by J. M. Giles, W. E. Hall, . Drane, F. A. Murray, and O. P. Hall. Prof. W. S. Yeates, State geologist, has l the salaries of river observers at Tallulah Falls, Groveland, Davisboro, Reids-, Milledgeville (part of year), Greensboro, Buckhead, Flovilla, Lithonia, Coving- Norcross, Demorest, Freemans, Cantons, Carters, and Cartecay. J. M. Young-d has furnished, without cost, gage heights for Augusta. The following United es Weather Bureau officials have furnished gage heights for the United States ather Bureau stations, as noted in the description of stations: D. Fisher, Augusta, ; J. B. Marbury, Atlanta, Ga.; and J. R. Weeks, Macon, Ga. Transportation has n furnished by J. S. B. Thompson, general agent of the Southern Railway; by Berkley, superintendent of the third division of the Seaboard Air Line Railway; Thomas K. Scott, general manager of the Georgia Railroad; by James T. Wright, -president and general manager of the Macon, Dublin and Savannah Railroad; J. H. Ellis, vice-president and general manager of the Atlanta, Knoxville and thern Railway; by C. A. Wickersham, president and general manager, Atlanta West Point Railway and Western Railway of Alabama; by W. L. Mapother, stant to president of Louisville Railroad. The above transportation was not fined to the State of Georgia, but was also furnished for the States of South olina, Alabama, Mississippi, and Tennessee.

ississippi.—District hydrographer, M. R. Hall, assisted by J. M. Giles and W. E. l. Gage heights were furnished by the United States Weather Bureau officials he stations at Yazoo City and Columbus.

orth Carolina.—District hydrographer, M. R. Hall, assisted by J. M. Giles, B. S. ne, and O. P. Hall. Dr. C. A. Schenck, director of the Biltmore School of Fory, paid the gage readers at Davidsons River, Sitton, and Pinkbed.

outh Carolina.—District hydrographer, M. R. Hall, assisted by J. M. Giles, W. E. l, B. S. Drane, and F. A. Murray.

SANTEE RIVER DRAINAGE BASIN.

antee River is formed in the central part of South Carolina by junction of Congaree and Wateree rivers, flows southeast, and ers the Atlantic Ocean about 10 miles north of Cape Romain. It a total length of about 180 miles (following the course of the river) l drains an area of about 15,000 square miles. It is a navigable eam for its entire length, and of course offers no opportunities for development of power.

Vateree River, the more northerly of the two parent streams, rises the eastern slope of the Blue Ridge, in McDowell County, N. C., l flows first northeast and then east, then bends abruptly southeast flows in this general direction across the south-central portion of rth Carolina and across the north-central part of South Carolina to junction with the Congaree, practically paralleling the course of lkin and Pedee rivers. This stream, throughout its course in rth Carolina, and also through that part of its course in South Caro- above the mouth of Wateree Creek, is known as Catawba River.

[a] Office of district hydrographer for South Atlantic States, 109 Temple Court, Atlanta, Ga.

The total length of the stream is about 270 miles in a straight line, and about 450 miles when all the windings are followed.

The Wateree is navigable as far as Camden, but above that point the fall is so great that navigation is impracticable. In 1826 and following years the State of South Carolina spent large sums in the attempt to render the river navigable by means of locks and dams. Some large and important works were constructed at great expense, but the undertaking was abandoned before their completion.

The drainage basin resembles that of the Yadkin in many respects, the upper portion of the stream flowing between parallel ranges of mountains, from which it receives many tributaries, affording much power. The average width of the valley of the main stream in North Carolina is only from 15 to 20 miles, and the fall in the main stream is considerable. The greater part of the drainage basin is hilly, and the upper portions are mountainous. A number of the tributary streams rise and flow for almost their entire length in high mountains. About 65 per cent of the upper part of the basin is in forest. Linville and John rivers, the principal tributaries in North Carolina, flow in country of this character, and their basins are almost entirely forested.

Wateree River crosses the fall line about 5 miles above Camden, S. C., in rapids about 5 miles in length, with a total fall of about 52 feet. The Great Falls of the Catawba are some distance above. This is the largest power in South Carolina, and one of the largest in the Southern States, the available fall being 173 feet.

The average rainfall in the basin is about 50 inches, the annual total increasing as the stream is ascended. The greatest flood ever experienced on the river was in May, 1901, the gage reading at the Rockhill station being 24.15 feet, and the measured discharge nearly 151,000 second-feet, or nearly 50 second-feet per square mile from the drainage basin above the station. The greatest flood previously experienced on the stream was in 1865. This was only about 2 feet lower than the flood of May, 1901, on the lower part of the river, but the May rise exceeded all previous records on the upper portion of the river by from 8 to 15 feet.

The minimum flow recorded for the Rockhill station is 1,300 second-feet, or about 0.43 second-foot per square mile. This occurred in September, 1895 and 1896. The maximum flow is about 116 times the minimum. During 1904 the minimum flow was 810 second-feet at the Catawba station. This was due to the storing of water at the new dam near Rockhill.

The Congaree, the second and more southerly of the two streams, which by their union form the Santee, is formed by the junction of Broad and Saluda rivers between Lexington and Richland counties, S. C., whence it flows in a general southeasterly direction, but in a very

rtuous channel, for about 60 miles to its junction with the Wateree. ne stream is navigable to Columbia, the capital of the State. There crosses the fall line, giving rise to a very fine water power, the only ne on the stream, which is being extensively used in the manufacturing enterprises of Columbia.

Broad River rises on the eastern slope of the Blue Ridge near Hickory Nut Gap, in the southwestern part of McDowell County and ne northeastern part of Henderson County, N. C., and flows in a eneral southeasterly direction across a portion of south-central North Carolina and north-central South Carolina to its junction with the Saluda at Columbia. The length of the river in a straight line is bout 128 miles, but it is much greater if the course of the river s followed.

In general character the drainage basin closely resembles those of he Yadkin and the Catawba. It lies entirely above the fall line, is vithout lakes, and is well wooded, especially in the upper portion, and he soil is generally loose and porous.

The rainfall of the basin averages about 51 inches, of which about 3 inches fall in spring, the same in summer, about 10 in autumn, and about 15 in winter. It is probable that the precipitation in the region about the headwaters is much greater than these amounts indicate.

The maximum flood recorded at the Alston station on this stream, 25 miles above Columbia, occurred in May, 1901, the estimated discharge being 131,000 second-feet, equivalent to about 28 second-feet per square mile. The minimum flow recorded at the same place is 1,250 second-feet, equivalent to 0.27 second-foot per square mile. This occurred during October, 1904. The maximum flow is therefore about 105 times the minimum.

Saluda River is formed in western South Carolina by the junction of the North, South, and Middle forks, and flows southeast to its junction with Broad River, the length of the stream being about 110 miles n a straight line. The three forks are mountain streams, and the haracter of the drainage basin is similar to that of Broad River.

The average rainfall over the basin of the stream is 51 inches, the mount and seasonal distribution being similar to that on the Broad. The maximum flood recorded at the Waterloo station on this stream ccurred in February, 1902, the rise being 23 feet above low water, nd the estimated discharge being about 18,500 second-feet, equivaent to about 18 second-feet per square mile. The minimum discharge so far recorded is 200 second-feet, or about 0.19 second-foot per square mile. This occurred during October, 1904. The maximum lischarge is therefore about 108 times the minimum.

The following pages give the results of the data collected in this drainage during 1904.

This station was established in order to continue the Catawba River after the Rockhill station had been aba very favorable section was found, but this one was sel most available one, and a temporary gage was put in by on September 11, 1903, in order to start the gage-height

The station is located at the bridge of the Southern Rail southeast of Catawba, S. C., and about 2 miles below the the Seaboard Air Line Railway. The deck bridge, from urements are made, is a three-span wooden-lattice structu feet long, with 250 feet of trestle approach on right bank on the left bank. At ordinary stages the river is about 4 at high stages the banks, which are rather high, will over extent, but all water will pass under the bridge and its The bed is partly rock and will probably shift little. Th straight above and below the bridge. The current is slu water—rather too much so for accurate work. The bridg at right angles with the current and corrections are widths in computing measurements.

The measurements are made from a plank footway c members of the bridge. The initial point for soundings edge of the capstone on the left bank pier. The gage 1 by 4 inch timber, reading from zero to 12 feet, and cor 5-foot sections and a 2-foot section fastened to a 3 by 10 which is driven into the bed of the river and spiked to a It is located on the left bank of the river, about 85 fee bridge. A second section of gage is attached to a tree small branch, about 200 feet from river, and the same dis the bridge. This section extends from 12 to 27 feet.

Bench mark No. 1 is the top of the joint plate on t bottom chord, at a point 44 feet from the initial point. is 31.70 feet above the zero of the gage. Bench mark No. ard copper plug set in a solid rock projecting from wa

Discharge measurements of Catawba River near Catawba, S. C., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
August 10	J. M. Giles	385	2,682	0.93	2.52	2,506
September 11	do	389	2,989	1.32	3.02	3,944
October 23	do	378	2,646	.85	2.30	2,253
December 11	do	375	2,649	.78	2.40	2,057
1904.						
March 7	J. M. Giles	392	3,641	1.76	4.00	6,421
March 8[a]	do	356	3,855	5.22	8.20	20,130
March 9[a]	do	355	3,887	4.53	7.85	17,610
March 21	do	379	3,086	.95	2.75	2,943
May 7	do	393	3,291	1.00	2.90	3,279
July 25	do	415	3,348	1.14	2.98	3,806
September 12	do	426	3,036	.33	1.65	1,016
November 21	do	436	3,345	.58	2.22	1,926

[a] Taken at Seaboard Air Line Railway bridge.

Mean daily gage height, in feet, of Catawba River near Catawba, S. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.40	3.00	3.50	2.75	2.50	2.50	5.50	3.35	2.90	1.80	1.85	1.95
2	2.30	3.20	3.30	2.75	2.45	5.40	3.65	4.00	3.30	[a]1.40	1.85	2.15
3	2.30	2.30	3.10	2.60	2.35	4.20	3.00	4.70	4.00	[a]1.65	1.80	2.45
4	2.30	2.30	3.30	2.65	2.45	3.70	2.65	3.70	3.25	1.85	2.15	2.55
5	2.30	2.30	3.00	2.60	2.80	3.05	2.50	3.40	4.05	1.75	3.15	2.70
6	2.20	2.30	3.00	2.65	3.35	2.85	2.35	4.60	5.40	1.65	2.45	5.05
7	2.10	2.50	4.20	2.60	2.95	3.20	2.30	4.05	3.65	1.70	2.85	4.65
8	2.20	2.90	7.30	2.60	2.80	3.70	2.35	10.05	2.80	1.75	2.45	3.65
9	2.40	3.50	7.40	2.70	2.80	2.90	2.25	6.55	2.45	1.80	2.15	3.00
10	2.40	3.30	5.00	2.80	3.35	2.65	2.35	5.40	2.65	1.95	2.05	2.70
11	2.40	3.20	4.00	3.20	4.70	2.50	2.40	4.95	3.85	1.90	2.00	2.50
12	2.30	3.00	3.60	2.95	3.85	2.65	2.35	7.50	1.70	1.85	1.90	2.60
13	2.30	2.20	3.30	2.75	3.30	2.70	2.90	5.75	2.30	1.80	3.00	2.40
14	2.20	2.50	3.30	2.65	3.00	2.45	2.70	3.75	2.15	1.75	4.90	2.25
15	2.00	2.50	3.60	2.55	3.10	2.35	2.20	3.05	2.20	1.70	4.05	2.30
16	2.10	2.90	3.20	2.60	3.30	2.25	2.10	4.70	2.15	1.70	3.05	2.20
17	2.30	2.30	2.95	2.60	2.90	2.20	2.10	5.10	2.20	1.85	2.60	2.25
18	2.20	2.30	2.95	2.55	2.75	2.20	2.35	3.00	2.10	1.80	2.30	2.35
19	2.20	2.40	2.90	2.55	2.70	2.40	2.05	2.65	2.15	1.75	2.15	2.50
20	2.40	3.40	2.75	2.45	3.15	2.55	2.05	2.55	1.95	[a]1.65	2.20	2.35
21	2.40	3.90	2.75	2.50	3.00	2.50	1.95	2.90	2.10	1.70	2.35	2.25
22	2.60	6.80	2.70	2.50	2.75	2.50	2.35	2.60	1.95	1.75	2.15	2.25
23	3.60	7.00	2.90	2.50	2.55	2.40	2.85	2.55	1.95	1.75	2.10	2.25
24	3.90	5.30	3.55	2.60	2.40	2.25	2.90	2.50	2.00	1.85	2.15	2.05
25	3.00	4.00	3.40	2.50	2.35	2.20	2.95	3.30	1.85	1.70	2.30	2.35
26	3.00	3.50	3.35	2.50	2.40	2.05	2.40	4.20	1.95	1.85	2.15	2.30
27	1.50	3.50	3.35	2.70	2.35	2.10	2.65	5.85	2.20	1.95	2.15	2.60
28	2.60	4.10	3.35	2.65	2.30	2.10	2.95	6.60	2.00	1.75	2.15	2.90
29	2.00	3.60	3.05	2.75	2.25	3.55	4.30	4.30	1.55	1.75	1.95	3.05
30	1.50	.....	2.95	2.55	2.20	6.35	4.05	2.90	1.60	1.80	1.95	3.15
31	2.40	.....	2.85	.....	2.35	.....	3.05	2.60	.....	1.85	.....	2.9

[a] Storing water at the new dam at Rock Hill, S. C., accounts for low days.

Rating table for Catawba River near Catawba, S. C., from September 11, 1903, to l 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Dis
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Seco*
1.40	810	2.10	1,655	2.80	3,200	3.50	5
1.50	900	2.20	1,825	2.90	3,470	3.60	5
1.60	1,000	2.30	2,015	3.00	3,750	3.70	5
1.70	1,110	2.40	2,225	3.10	4,035	3.80	6
1.80	1,230	2.50	2,450	3.20	4,325	3.90	6
1.90	1,360	2.60	2,690	3.30	4,615	4.00	6
2.00	1,500	2.70	2,940	3.40	4,910		

The above table is based upon 12 discharge measurements made during 19 It is well defined between gage heights 1.5 feet and 4.0 feet. Above 4.0 i fairly determined. The table has been extended beyond these limits. Ab height 3.60 feet the rating curve is a tangent, the difference being 300 per te

Estimated monthly discharge of Catawba River near Catawba, S. C., for 1903 a

[Drainage area, 1,514 square miles.]

Month.	Discharge in second-feet.			Run-
	Maximum.	Minimum.	Mean.	Second-feet per square mile.
1903.				
September 11-30	16,300	1,825	3,962	2.62
October	4,910	1,825	2,313	1.53
November	6,400	2,015	2,754	1.82
December	3,470	2,015	2,269	1.50
1904.				
January	6,400	900	2,313	1.53
February	15,700	1,825	4,783	3.16
March	16,900	2,940	5,366	3.54
April	4,325	2,337	2,808	1.85
May	8,800	1,825	3,344	2.21
June	13,750	1,578	3,599	2.38
July	11,200	1,480	3,172	2.10
August	24,850	2,450	7,629	5.04
September	10,900	950	2,883	1.90
October	1,480	810	1,198	.791
November	9,400	1,230	2,451	1.62
December	9,850	1,480	2,994	1.98
The year	24,850	810	3,545	2.34

CATAWBA RIVER NEAR MORGANTON, N. C.

The original station was established June 19, 1900, in connection with the hydrographic investigation of the Southern Appalachian area, at which time a wire gage was installed on the highway bridge on the road from Morganton to Hartland. In May, 1901, the river throughout this part of its course rose from 8 to 15 feet higher than ever before known, and the bridge and gage were destroyed. The present station was established May 15, 1903, by E. W. Myers, assisted by B. S. Drane, at the bridge which was built to replace the one carried away by the flood of May, 1901. The station is 1 mile north of Morganton and about 200 yards below the mouth of Upper Creek. The standard chain gage with inclosed scale is attached to the lower chord of the downstream side of the bridge. The zero of the scale is about 94 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 36.95 feet. The gage is read once each day by Hort Edmunson. Discharge measurements are made from the downstream side of the single-span steel highway bridge to which the gage is attached. The initial point for soundings is the left end of the downstream hand rail. Distances are laid off along this rail and are marked in white paint. The channel is straight for about 200 feet above and for about 600 feet below the station. The current is swift. The right bank is low and overflows to a slight extent on account of erosion, but all water passes beneath the approach to the bridge. The left bank is high, rocky, and wooded. The bed of the stream is rocky, with sand and gravel near the right bank.

Bench mark No. 1 is the left side of the upper surface of the sixth floor beam at the downstream side of the bridge, 13 feet to the right of the zero of the gage. The point is indicated by a spot of white paint and the letters B. M. When the gage reads zero the water surface is 34.77 feet below this point. Bench mark No. 2 is a copper plug set in cement in a rock on the left bank 24.3 feet back of the initial point for soundings, and is 3 feet downstream from the line of the downstream truss. It is about 1½ feet above the road and is inclosed in a circle of white paint and marked "B. M." Its elevation is 37.37 feet above datum of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Catawba River near Morganton, N. C., in 1903 and 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
February 13	E. W. Myers	850	3.36	2.77	2,861
May 5	do	726	2.28	2.04	1,656
May 5	do	726	2.33	2.05	1,698
June 25	do	611	2.09	1.93	1,276
June 25	do	611	2.10	1.95	1,282
August 21	B. S. Drane	552	2.14	1.77	1,181
August 21	do	554	2.15	1.76	1,193
October 28	do	458	1.15	1.16	528
October 28	do	462	1.21	1.18	559
December 11	do	439	1.09	1.19	480
December 11	do	440	1.12	1.22	493
1904.					
February 17	B. S. Drane	435	1.24	1.23	539
March 18	do	622	1.31	1.56	816
March 18	do	615	1.37	1.56	843
May 5	do	641	2.04	2.08	1,305
May 27	do	458	1.68	1.48	770
July 21	do	415	1.08	1.01	447
August 19	do	427	1.49	1.28	637
September 29	do	356	1.10	1.04	391
September 29	do	356	1.11	1.01	395
December 15	do	394	1.15	1.15	454
December 16	do	405	1.23	1.18	500

Main daily gage height, in feet, of Catawba River near Morganton, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.25	1.30	1.80	1.55	1.35	4.45	1.95	3.10	1.70	0.95	1.00	1.10
.....	1.25	1.30	1.65	1.50	1.35	3.25	1.70	2.35	2.20	.95	1.00	1.15
.....	1.25	1.25	1.60	1.45	3.30	2.40	1.50	1.90	1.55	.95	1.10	1.25
.....	1.20	1.25	1.55	1.40	2.60	2.10	1.35	1.70	1.90	.90	1.75	1.40
.....	1.20	1.25	1.50	1.40	2.15	1.90	1.50	1.95	2.20	.95	1.50	1.70
.....	1.20	1.25	1.50	1.40	1.80	1.75	1.35	2.30	1.50	.95	1.30	2.05
.....	1.50	1.35	9.20	1.50	1.70	1.95	1.30	2.45	1.40	1.10	1.15	1.55
.....	1.30	1.90	4.30	1.55	3.50	2.00	1.30	2.00	1.30	1.00	1.10	1.40
.....	1.20	1.70	2.80	2.65	4.10	1.65	1.35	1.70	1.30	1.05	1.10	1.35
.....	1.20	1.65	2.30	1.70	3.05	1.60	1.30	2.10	1.30	1.00	1.05	1.35
.....	1.20	1.50	2.10	1.60	2.40	1.70	1.30	2.05	1.35	.95	1.00	1.35
.....	1.20	1.40	1.90	1.60	2.10	1.55	1.35	2.40	1.30	.95	1.00	1.25
.....	1.20	1.40	1.80	1.60	2.00	1.45	1.30	1.85	1.25	.90	1.80	1.25
.....	1.20	1.35	1.80	1.55	1.95	1.45	1.25	1.65	1.20	.90	1.50	1.20
.....	1.20	1.35	1.75	1.50	1.90	1.40	1.25	1.50	1.15	.95	1.35	1.15
.....	1.20	1.35	1.65	1.45	1.70	1.45	1.20	1.50	1.10	.90	1.25	1.15
.....	1.15	1.30	1.60	1.55	1.65	1.65	1.15	1.40	1.05	.85	1.20	1.20
.....	1.15	1.30	1.60	1.45	2.30	1.60	1.10	1.35	1.05	.95	1.20	1.25
.....	1.15	1.30	1.55	1.40	2.90	2.05	1.10	1.30	1.10	.90	1.10	1.20
.....	1.15	1.30	1.50	1.35	1.80	1.80	1.05	1.40	1.10	.90	1.00	1.15
.....	1.20	1.30	1.50	1.40	1.60	1.55	1.10	1.35	1.10	.90	1.05	1.15
.....	1.25	2.80	1.60	1.40	1.60	1.45	1.10	1.40	1.05	.90	1.05	1.10
.....	2.40	2.40	1.60	1.45	1.55	1.40	1.20	2.40	1.05	.90	1.05	1.05
.....	1.65	1.85	1.90	1.35	1.60	1.35	1.15	2.40	1.05	.90	1.10	1.05
.....	1.50	1.70	2.00	1.35	1.60	1.30	2.40	1.60	1.05	.95	1.00	1.25
.....	1.40	1.60	1.90	1.60	1.70	1.30	1.70	1.50	1.05	1.00	1.05	1.30
.....	1.40	1.80	1.85	1.60	1.45	1.40	1.30	2.00	1.05	.95	1.05	1.75
.....	1.35	1.80	1.80	1.45	1.50	1.65	1.65	1.65	1.00	.95	1.05	2.05
.....	1.35	1.80	1.70	1.40	1.55	1.85	1.50	1.40	1.00	1.00	1.10	1.55
.....	1.35	.....	1.60	1.35	1.65	2.50	1.40	1.30	.95	.95	1.10	1.50
.....	1.30	.....	1.55	.....	5.25	.....	1.35	1.40	.....	1.00	.....	1.45

ting table for Catawba River near Morganton, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	252	1.40	702	2.00	1,460	2.60	2,610
.90	307	1.50	800	2.10	1,640	2.70	2,805
1.00	372	1.60	908	2.20	1,830	2.80	3,000
1.10	447	1.70	1,026	2.30	2,025	2.90	3,195
1.20	527	1.80	1,156	2.40	2,220	3.00	3,390
1.30	612	1.90	1,300	2.50	2,415		

The above table is based upon discharge measurements made during 1903 and 4. It is well defined between gage heights 1 foot and 2 feet. Above 2 feet the ection of the tangent is determined by one measurement at 2.77 feet. The table s been extended beyond these limits. Above gage height 2.2 feet the rating curve t tangent, the difference being 195 per tenth. Above 2 feet the estimates can be nsidered a very rough approximation. This table is the same as the 1903 table, th the exception of a very slight change below 1.3 feet gage.

Estimated monthly discharge of Catawba River near Morganton, N. C., for 1904.

[Drainage area, 758 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	2,220	487	643	0.848	0.978
February	3,000	569	915	1.21	1.30
March	15,480	800	1,759	2.32	2.68
April	2,708	657	846	1.12	1.25
May	7,777	657	1,878	2.48	2.86
June	6,217	612	1,333	1.76	1.96
July	2,220	410	711	.938	1.08
August	3,585	612	1,293	1.71	1.97
September	1,830	339	639	.843	.940
October	447	280	338	.446	.514
November	1,156	372	515	.679	.758
December	1,550	410	679	.896	1.03
The year	15,480	280	962	1.27	17.32

JOHN RIVER NEAR MORGANTON, N. C.

This station was established as a bench-mark station. It is locate at the iron highway bridge on the Lenoir road, about 3 miles fro Morganton, N. C. Discharge measurements are made from the dow stream side of the single-span bridge. The initial point for soundin is the left end of the main span, downstream side, over the middle the left pier. The channel is curved for about 300 feet above a straight for 500 feet below the station. The current is swift. Bo banks are high, wooded, and not liable to overflow. The bed of th stream is rocky along the left bank, which is composed of rock, a sandy along the right bank. There is but one channel at all stages.

The bench mark is the upper edge of the end of a bar extendin from the floor beam to a brace at the downstream end of the secon floor beam from the left pier, 32 feet from the initial point for sound ings. Its elevation is 30.00 feet above datum.

Discharge measurements of John River near Morganton, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 27	B. S. Drane	64	172	1.72	1.66	295
July 21	do	61	163	1.26	1.44	205
August 19	do	62	170	1.40	1.53	238
September 29	do	61	135	1.13	1.31	153
December 16	do	61	146	1.00	1.27	146

WATEREE RIVER NEAR CAMDEN, S. C.

Camden, S. C., is on the Wateree River, 45 miles above its mouth, and about 5 miles below the fall line. The drainage area above the station is 2,635 square miles.

A station has been maintained here by the United States Weather Bureau since 1891. The gage is at the toll bridge about 2 miles west of Camden. Measurements are made from this bridge, which consists of two iron spans, about 180 feet each, supported by tubular iron piers, and has short wooden approaches with brick abutments on both banks. The bridge keeper is also the river observer. The Weather Bureau gage is in three sections, the lower section being a timber fastened to a log near the right bank and about 15 feet above the bridge, and reading from 0 to 8 feet. The second is a timber fastened to an ash tree on right bank about 25 feet above the bridge, and reading up to 15 feet. The third section, 15 to 32 feet, is painted on the upstream cylindrical pier on right bank. Only the third section, painted on the iron pier, is in good condition. On August 12, 1904, a new chain gage was put in by M. R. Hall, set to accord with the pier gage. The gage is a 24-inch iron top box, with outside scale. It is located at the upstream end of a floor beam, 40 feet from the right bank pier, and is fastened to a short vertical timber resting on the floor beam, and clamped to the double rod hanger. The bottom of the box is about 3 feet above the bridge floor, and is 41.53 feet above gage datum. The length of the chain is 43.53 feet.

Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the edge of the right bank brick abutment. Both banks are high, but are liable to overflow at time of floods. Both are open and cultivated except along the bank where there are trees. The channel is 270 feet wide at low water, and is broken by one pier. The current is smooth and moderately swift, except at lowest stages. The bed is sand and is probably changing. The river below has a very small slope, which is unfavorable for good rating at high stages, as the position of flood crest will affect the slope largely.

Bench mark No. 1 is the top of the upstream end of the floor bea about 40 feet from right bank pier, at a point directly under the gage Its elevation is 36.85 feet above the gage datum. Bench mark No. is two large wire nails driven horizontally into a sycamore tree o right bank of river, and upstream side of the road, 110 feet from th pier. Its elevation is 31.27 feet above gage datum.

Discharge measurements of Wateree River near Camden, S. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharg
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-fe*
July 23	J. M. Giles	264	3,249	1.47	7.10	4,7
August 11	M. R. Hall	324	6,627	1.97	17.80	13,0
August 12	do	324	7,345	2.68	20.20	19,6
September 13	J. M. Giles	270	2,215	.63	3.60	1,4
September 14	do	271	2,538	.91	4.60	2,3
November 19	do	274	2,538	.99	4.52	2,5

Mean daily gage height, in feet, of Wateree River near Camden, S. C., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec
1		3.00	3.20	3.70	17	4.60			4
2		3.00	4.20	3.80	18	4.60			5
3		3.30	4.00	4.90	19	4.00			5
4		3.00	4.20	7.10	20	4.00			5
5		3.30	5.80	5.50	21	4.00			4
6		3.40	7.40	10.00	22	4.50			4
7		3.40	5.10	14.10	23	3.90	3.50		4
8		3.20	6.20	11.10	24	4.00	3.40		4
9		3.30	5.20	8.10	25	4.10	3.00		4
10		3.50	4.70	6.50	26	3.90	3.50		4
11	5.40	3.50	4.50	5.50	27	3.50	4.50	4.00	
12	8.90	3.90	4.30	5.50	28	4.10	4.00	3.70	
13	4.80	3.80		5.00	29	4.20	4.00	3.70	
14	4.80	3.80		4.60	30	3.80	3.90	3.80	
15	4.80	3.60		4.50	31		3.60		
16	4.80			4.60					

BROAD RIVER (OF THE CAROLINAS) AT ALSTON, S. C.

This station was established July 3, 1896, by E. W. Myers at Southern Railroad bridge at Alston, S. C., about 27 miles above Colu bia. The standard chain gage is located in the second span from left end of the bridge. The zero of the scale is 74 feet from the ini point for soundings. The length of the chain from the end of weight to the marker is 39.22 feet. The observer is G. M. Heron farmer of Alston, S. C., who reads the gage once each day. Discha measurements are made from the downstream side of the steel throu

span railway bridge to which the gage is attached. The initial point or soundings is the end of the second span nearest the left bank over ıe center of the pier. At flood stages some water passes behind this oint. The channel above the station is straight, but the current is ıterrupted by a large island and passes under the bridge at an angle. elow the bridge the channel is straight for about one-half mile. oth banks are high and all water passes beneath the bridge. The d of the stream is of sand and silt and is slightly shifting. There but one channel at all stages.

Bench mark No. 1 is a point on the right side of the downstream d of the fifth floor beam from the left end of the second span from left end of the bridge. It is marked in white paint and is indied by the letters B. M. When the gage reads zero the water surc is 36.44 feet below this point. Bench mark No. 2 is a standard per bolt set in rock on the left bank on the hillside 50 yards from river and 52 feet downstream from the center line of the trestle proach to the bridge and is 21.2 feet from the corner of the pump ıse. The rock is white and the bench mark is under a small china e. This bench mark is 9.85 feet below the bench mark on the dge, making its elevation 26.59 feet above the gage datum.

The observations at this station during 1904 have been made under direction of M. R. Hall, district hydrographer.

charge measurements of Broad River (of the Carolinas) at Alston, S. C., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
rch 23	E. W. Myers		12,300	5.78	19.85	71,140
ril 17	E. C. Murphy		3,764	3.48	7.74	15,060
ıe 24	B. S. Drane		3,376	3.14	6.20	10,590
gust 6	J. M. Giles		2,904	2.84	5.58	8,259
gust 6	M. R. Hall		2,904	2.74	5.58	7,954
ptember 10	J. M. Giles		2,635	2.74	4.86	7,218
tober 22	do		1,341	2.40	3.45	3,219
cember 10	do		1,572	2.19	3.75	3,437
1904.						
ıuary 27	W. E. Hall	519	1,809	2.28	4.10	4,128
ırch 3	J. M. Giles	528	1,835	2.61	4.50	4,786
ıy 6	do	521	1,757	2.20	4.18	3,861
ly 22	do	521	1,847	2.42	4.10	4,465
ptember 15	do	429	1,255	1.65	2.95	2,065
vember 18	do	489	1,524	1.85	3.55	2,817

Mean daily gage height, in feet, of Broad River (of the Carolinas) at Alston, S. C., 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.70	3.80	4.50	4.25	3.85	3.50	5.70	3.55	4.10	2.55	2.40	3.00
2	3.60	3.60	4.50	4.25	3.80	5.30	6.60	6.75	4.00	2.60	2.60	3.35
3	3.60	3.80	4.50	4.20	3.40	4.80	4.50	7.00	4.30	2.55	2.50	4.95
4	3.60	3.70	4.50	4.05	4.10	4.30	3.85	6.60	4.00	2.35	2.65	4.25
5	3.30	3.70	4.40	3.75	4.45	3.90	3.20	5.00	4.20	2.20	3.90	3.70
6	3.30	3.70	4.30	4.05	4.20	3.60	3.00	5.50	5.20	2.45	4.00	8.70
7	3.40	3.70	5.50	4.05	4.10	3.20	3.10	5.20	4.40	2.65	3.60	8.00
8	3.50	4.40	9.95	4.30	3.90	4.70	3.30	12.45	3.80	2.50	3.15	5.70
9	3.60	4.70	8.35	4.25	3.95	4.40	3.05	13.00	3.40	2.70	3.15	4.65
10	3.60	4.90	6.35	4.60	4.45	3.80	3.05	11.50	3.30	2.70	3.10	4.35
11	3.50	4.60	5.50	4.65	4.70	3.50	3.25	9.30	3.20	2.40	3.00	3.95
12	3.40	4.40	5.10	4.05	4.20	3.40	3.30	8.70	3.10	2.55	3.00	3.35
13	3.60	4.20	4.90	4.10	3.95	4.40	4.10	7.30	2.80	2.55	3.50	3.60
14	3.60	4.10	4.90	4.10	3.85	3.50	3.30	5.20	2.85	2.65	6.10	3.70
15	3.60	3.90	4.70	4.00	3.80	3.45	3.05	4.55	3.00	2.65	5.60	3.70
16	3.50	3.80	5.00	3.95	4.05	3.20	2.75	7.50	2.85	2.40	4.45	3.75
17	3.60	4.00	4.55	4.00	4.00	3.20	3.40	5.90	2.65	2.50	3.80	3.70
18	3.50	3.90	4.40	4.05	3.85	3.20	3.20	4.70	2.60	2.20	3.55	3.70
19	3.60	3.90	4.35	3.80	3.65	3.10	3.05	3.85	2.80	2.45	3.45	3.65
20	3.60	6.40	4.30	4.05	3.70	5.00	2.75	3.90	2.45	2.65	3.35	3.35
21	3.60	6.60	4.20	3.95	3.50	5.10	2.70	4.50	2.95	2.55	3.25	3.60
22	3.60	11.25	3.90	3.95	3.45	4.45	3.75	3.85	2.80	2.60	2.75	3.50
23	6.50	11.30	4.30	3.95	3.35	3.90	4.95	3.30	2.75	2.60	3.10	3.40
24	5.30	8.20	4.90	3.90	3.10	3.40	6.95	3.50	2.65	2.45	3.35	3.40
25	4.80	6.10	5.50	3.85	3.10	3.40	4.25	3.70	2.50	2.25	3.20	3.50
26	4.20	5.30	5.40	3.95	3.10	3.20	3.25	3.85	2.60	2.50	3.05	3.35
27	4.20	4.40	5.60	4.10	2.95	2.90	3.50	11.10	2.45	2.90	3.00	3.25
28	3.90	4.80	4.95	4.45	3.20	2.75	3.30	10.70	2.60	2.80	3.00	4.00
29	3.80	4.70	4.50	4.15	3.15	2.95	5.85	14.00	2.80	2.65	2.65	5.25
30	3.90	.....	4.50	3.95	3.40	4.20	5.05	5.70	2.70	2.70	2.90	4.55
31	3.90	.....	4.30	.....	3.20	.....	3.90	4.50	.....	2.60	.....	4.30

Rating table for Broad River (of the Carolinas) at Alston, S. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.20	1,250	3.20	2,590	4.20	4,750	6.00	9,600
2.30	1,340	3.30	2,770	4.40	5,250	6.50	11,100
2.40	1,440	3.40	2,960	4.60	5,750	7.00	12,600
2.50	1,550	3.50	3,150	4.80	6,300	7.50	14,100
2.60	1,670	3.60	3,350	5.00	6,850	8.00	15,650
2.70	1,800	3.70	3,560	5.20	7,400	8.50	17,275
2.80	1,940	3.80	3,780	5.40	7,950	9.00	18,900
2.90	2,090	3.90	4,010	5.60	8,500	9.50	20,525
3.00	2,250	4.00	4,250	5.80	9,050	10.00	22,150
3.10	2,420						

The above table is based upon 21 discharge measurements made during 1901 to 1904. *It is well defined* between gage heights 3.0 feet and 10.0 feet.

onthly discharge of Broad River (of the Carolinas) at Alston, S. C., for 1904.

[Drainage area, 4,609 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	11,100	2,770	3,921	0.851	0.981
.....	26,550	3,350	7,237	1.57	1.69
.....	21,990	4,010	7,097	1.54	1.78
.....	5,888	3,670	4,480	.972	1.08
.....	6,025	2,170	3,695	.802	.925
.....	7,675	1,870	3,921	.851	.950
.....	12,450	1,800	4,169	.905	1.04
.....	36,800	2,770	12,200	2.65	3.06
.....	7,400	1,495	2,761	.599	.668
.....	2,090	1,250	1,614	.350	.404
.....	9,900	1,440	3,096	.672	.750
.....	17,920	2,250	4,886	1.06	1.22
year	36,800	1,250	4,923	1.07	14.56

TIGER RIVER AT DELTA, S. C.

ation was established as a bench-mark station. It is located eaboard Air Line Railway bridge, one-third mile east of t at Delta, S. C. It is best reached by driving from Whit- miles west. Discharge measurements are made from the am side of the single-span, steel, through bridge, 202.5 feet ring trestle approaches at each end. The initial point for s is the right end of the bridge, downstream side. Sounding e marked on the guard rail. The channel is straight for 00 feet above and below the station. The current is swift. nks are low, partly wooded, and subject to overflow during er. The bed of the stream is composed of sand. There is but nel, divided during high water by the piers of the bridge and pports. The bridge crosses the river at a slight angle. The ark is the top of the downstream end of the second floor beam right bank. Its elevation is 36.00 feet above gage datum.

Discharge measurements of Tiger River at Delta, S. C., in 1904.

Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
	Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
..... J. M. Giles.....	108	409	1.40	1.85	573
.....do	109	324	2.09	2.35	678
10 .....do	106	314	1.18	1.67	369

ENOREE RIVER NEAR WHITMIRE, S. C.

This station was established as a bench-mark station. It is located at the Seaboard Air Line Railway bridge, 1¼ miles east of Whitmire, S. C. There is a highway bridge one-third mile below, and a grist-mill three-fourths mile below has a dam with 2-foot fall. Discharge measurements are made from the downstream side of the single-span deck bridge, 151 feet long. There are 15 bents of trestle approach at the left and 22 bents at the right bank. The initial point for soundings is the right end of the bridge downstream side. Sounding points are marked on the guard rail. The channel is straight for about 300 feet above and one-fourth mile below the station. The current is swift. Both banks are low, clean, and subject to overflow under the trestle approaches. The bed of the stream is composed of gravel and sand. There is but one channel at low and ordinary stages, broken during high water by the piers and trestle work of the bridge. The operation of the mill below will affect the flow of the stream. The bench mark is the top of stringer on the downstream side of the bridge, 50 feet from the initial point for soundings. Its elevation is 56.00 feet above gage datum.

Discharge measurements of Enoree River near Whitmire, S. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 23	J. M. Giles	90	237	1.96	1.90	464
May 10	do	100	186	1.65	1.60	307
September 10	do	101	193	1.86	1.20	359

SALUDA RIVER NEAR WATERLOO, S. C.

This station was established by E. W. Myers, August 30, 1896. It is located at the Charleston and Western Carolina Railroad bridge between Coronaca and Waterloo, 3 miles from Waterloo and 9 miles from Greenwood. It is 1 mile below the mouth of Reedy River. The standard chain gage is on the downstream side of the bridge, on the span next the left bank. The length of the chain from the end of the weight to the marker is 45.73 feet. The gage is read once each day by R. N. Cunningham. Discharge measurements are made from the railway bridge and its approaches. The bridge is a steel through bridge of two spans about 125 feet each, with wooden trestles 600 feet long on the left bank and 200 feet on the right bank. The initial point for soundings is the end of the guard rail of the trestle on the left bank. The channel is straight for about 600 feet above and below the station. Both banks are low and wooded and are subject to overflow, but a

er passes beneath the bridge and its approaches. The bed of the am is sandy and muddy and is slightly shifting. There is but one nnel at all stages. Its width at low water is 250 feet, the channel roken by one pier, and the velocity is moderate.

ench mark No. 1 is a point on the top surface of the downstream of the first floor beam to the left of the center pier. Its elevation 4.64 feet above the gage datum. Bench mark No. 2 is a copper t set in a granite bowlder on the right bank of the stream 470 feet m the end of the trestle (measured along the railroad track) and feet upstream from the center of the track. Its elevation is 61.44 t above gage datum. The rock is near two small persimmon trees. 'he observations at this station during 1904 have been made under direction of M. R. Hall, district hydrographer.

Discharge measurements of Saluda River near Waterloo, S. C., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
ch 23	E. W. Myers	.....	4,384	2.96	17.40	12,970
il 18	E. C. Murphy	.....	1,213	2.87	9.40	3,481
il 18	B. S. Drane	.....	1,230	3.04	9.60	3,739
il 21	E. W. Myers	.....	1,243	3.01	9.20	3,747
e 25	B. S. Drane	.....	795	1.73	6.76	1,375
e 25	do	.....	829	1.84	7.03	1,527
ust 5	J. M. Giles	.....	695	2.22	6.88	1,542
ust 5	M. R. Hall	.....	695	2.10	6.88	1,458
tember 9	J. M. Giles	.....	628	1.98	6.38	1,245
ober 21	do	.....	615	1.91	6.28	1,176
ember 9	do	.....	504	1.75	5.90	883
1904.						
uary 26	W. E. Hall	160	371	1.29	4.98	479
ch 2	J. M. Giles	192	671	2.16	6.85	1,450
ch 19	do	191	654	2.02	6.74	1,322
y 5	do	183	540	1.64	5.86	887
y 21	do	163	334	1.73	5.02	578
y 26	do	182	460	1.67	5.57	769
ember 16	do	182	593	1.62	6.03	963

Mean daily gage height, in feet, of Saluda River near Waterloo, S. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.75	5.60	6.05	6.20	5.65	5.80	6.40	4.70	6.45	5.20	5.05	5.20
2	5.70	5.65	6.15	5.95	5.55	7.75	6.05	7.10	5.85	5.05	5.20	5.75
3	5.50	6.50	6.40	6.45	5.95	5.90	5.15	9.30	6.45	4.20	5.05	6.05
4	5.10	5.45	5.95	6.10	6.00	6.45	4.40	7.20	5.85	5.15	5.70	5.40
5	5.65	5.70	6.10	6.15	5.85	6.05	4.25	6.20	6.45	4.75	5.55	6.95
6	5.95	5.65	5.60	6.65	5.95	4.95	5.45	6.45	6.25	4.75	5.40	8.95
7	5.45	5.65	9.75	6.00	6.05	5.40	5.40	6.65	5.65	4.45	4.45	7.25
8	5.95	6.40	10.60	6.50	5.50	5.75	5.60	19.00	5.75	5.30	5.95	6.20
9	5.80	6.75	8.20	6.85	5.30	6.40	6.65	19.10	5.60	4.65	5.40	5.90
10	5.60	6.65	6.90	7.15	6.10	5.25	5.20	12.75	5.65	4.25	5.35	5.85
11	4.85	6.10	5.90	6.70	5.75	6.15	4.35	9.80	5.65	5.20	5.25	5.90
12	5.65	6.10	6.10	6.00	6.40	5.20	5.15	7.60	5.00	5.15	6.05	5.00
13	5.70	6.55	7.00	5.60	5.20	4.55	5.40	7.60	5.65	4.20	6.05	5.75
14	5.65	6.40	7.30	6.60	6.70	5.35	5.00	7.30	5.50	5.15	5.45	5.55
15	5.60	6.90	6.25	6.40	5.40	5.40	5.45	6.40	5.35	5.00	6.50	5.60
16	5.60	5.60	6.10	6.75	5.25	5.35	4.45	6.45	4.15	5.05	5.50	5.60
17	5.65	6.45	5.70	6.40	6.40	5.45	5.00	6.20	5.05	5.00	5.55	6.10
18	5.20	6.00	5.90	5.80	6.10	6.55	4.30	5.90	5.35	5.15	5.40	5.50
19	5.40	6.50	6.10	6.45	7.10	4.70	5.20	6.15	4.65	5.15	6.00	4.80
20	5.60	6.80	6.60	5.25	6.15	5.70	4.05	6.25	5.40	4.95	5.05	5.60
21	5.70	9.10	5.75	6.35	6.10	5.85	5.00	6.85	5.55	4.70	4.35	5.60
22	7.10	11.10	5.95	6.30	5.40	5.95	5.85	5.60	5.05	4.30	5.30	5.85
23	6.90	11.00	6.00	5.85	4.65	5.30	4.80	5.90	5.55	4.00	5.35	5.60
24	7.10	6.90	7.15	6.30	5.55	5.35	5.70	5.70	6.00	3.95	5.45	5.85
25	6.40	5.80	7.30	5.35	5.65	5.35	5.00	5.70	5.25	3.90	5.25	5.35
26	4.80	5.60	6.40	6.50	5.75	5.95	5.75	10.10	4.30	5.20	5.35	4.10
27	5.60	5.55	7.00	6.05	5.45	4.50	5.55	11.45	5.20	5.00	5.05	5.35
28	5.90	7.05	6.75	6.85	3.95	4.30	7.60	16.90	5.80	5.10	4.35	6.85
29	5.70	6.20	6.00	5.85	5.40	5.30	7.10	7.90	4.55	5.00	5.10	6.20
30	5.85	.....	5.55	6.15	4.80	5.45	6.40	6.80	4.95	4.75	5.35	5.90
31	5.60	.....	5.95	.....	5.95	.....	5.70	6.25	.....	4.25	.....	6.40

NOTE.—The lower gage heights during the latter part of the year were probably caused by the filling of the new dam at Ware Shoals.

Rating table for Saluda River near Waterloo, S. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.90	200	4.90	472	5.90	930	7.80	2,100
4.00	219	5.00	510	6.00	985	8.00	2,250
4.10	240	5.10	550	6.20	1,095	8.20	2,400
4.20	262	5.20	592	6.40	1,205	8.40	2,560
4.30	286	5.30	636	6.60	1,320	8.60	2,725
4.40	312	5.40	682	6.80	1,440	8.80	2,900
4.50	340	5.50	730	7.00	1,560	9.00	3,085
4.60	370	5.60	780	7.20	1,690	9.50	3,590
4.70	402	5.70	830	7.40	1,820	10.00	4,150
4.80	436	5.80	880	7.60	1,960		

going table is based upon discharge measurements made during 1903 and
s well defined between gage heights 5 feet and 7 feet. Above 7 feet the
mewhat uncertain. Above gage height 10 feet the rating curve is a tan-
difference being 120 per tenth. The table is the same as the 1903 table
et gage.

nated monthly discharge of Saluda River near Waterloo, S. C., for 1904.

[Drainage area, 1,056 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	1,625	436	868	0.822	0.948
.....	5,470	706	1,460	1.38	1.49
.....	4,870	755	1,398	1.32	1.52
.....	1,657	614	1,130	1.07	1.19
.....	1,625	210	857	.812	.936
.....	2,065	286	798	.756	.844
.....	1,960	229	730	.691	.797
.....	15,070	402	3,118	2.95	3.40
.....	1,233	251	738	.699	.780
.....	636	200	444	.420	.484
.....	1,260	299	683	.647	.722
.....	2,945	436	961	.910	1.05
year	15,070	200	1,099	1.04	14.16

REEDY RIVER NEAR WATERLOO, S. C.

ation was established as a bench-mark station. It is located
ghway bridge 2 miles from Waterloo, S. C., on the road to
od, S. C. Discharge measurements are made from the
am side of the single-span, wooden covered, highway bridge
ng, having a trestle approach of 20 feet at the right bank and
t the left bank. The initial point for soundings is the left end
wnstream truss. The channel is curved for about 500 feet
d straight for about 500 feet below the station. The current
ate. Both banks are high and wooded. The right bank over-
ler the trestle approach, and the left bank over a wide bottom
xtreme floods. The bed of the stream is composed of sand.
but one channel at low and ordinary stages, broken during
er by the piers and trestle bents of the bridge. The bench
he top of the downstream bottom chord of truss, 20 feet from
l point for soundings. Its elevation is 19.00 feet above the
um.

Discharge measurements of Reedy River near Waterloo, S. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
July 27	J. M. Giles	75	106	1.62	0.86	172
September 8	do	76	188	1.32	1.15	248

MISCELLANEOUS MEASUREMENTS IN SANTEE RIVER DRAINAGE BASIN.

The following is a list of miscellaneous discharge measurements made in Santee River drainage basin during 1904:

Catawba River near Rock Hill, S. C.—A measurement was made January 30 at Culp's bridge, 8 miles northeast of Rock Hill. The gage height was obtained from gage at Catawba Power Company's dam.

Width, 320 feet; area, 1,797 square feet; mean velocity, 0.92 foot per second; gage height, 99.97 feet; discharge, 1,648 second-feet.

Catawba River near Belmont, N. C.—A measurement was made March 4 at the Southern Railway bridge, 2 miles east of Belmont. The bench mark is the top of the inside bar of the downstream lower chord, at the first crossbeam from the third pier from the left bank. Its elevation was 26.70 feet above the water surface.

Width, 312 feet; area, 1,415 square feet; mean velocity, 1.54 feet per second; discharge, 2,181 second-feet.

Catawba River (South Fork) near Belmont, N. C.—On March 4 a measurement was made at the Southern Railway bridge, 2 miles west of Belmont. The bench mark is the top of crossbeam 67 feet from the left end of the bridge, 25.00 feet above the datum of the gage.

Width, 156 feet; area, 277 square feet; mean velocity, 2.27 feet per second; gage height, 1.70 feet; discharge, 629 second-feet.

On March 5 a measurement was made at the wagon bridge 2 miles southwest of Belmont. The bench mark is the top of the first crossbeam from the left end of the bridge. Its elevation is 24.00 feet above the datum of the gage.

Width, 130 feet; area, 249 square feet; mean velocity, 2.75 feet per second; gage height, 2.35 feet; discharge, 684 second-feet.

Saluda River near Waterloo, S. C.—A measurement was made, September 8, at the wagon bridge on the road to Greenwood, S. C. The bench mark is the top of the downstream end of the second crossbeam from the left end of the bridge, 28.65 feet above the datum of the gage.

Width, 145 feet; area, 314 square feet; mean velocity, 1.85 feet per second; discharge, 580 second-feet.

SAVANNAH RIVER DRAINAGE BASIN.

Savannah River is formed by the junction of Tugalo and Seneca ;ers, which unite about 100 miles above Augusta, Ga. It flows in a utheasterly direction, forming the boundary between Georgia and ›uth Carolina, and empties into the Atlantic Ocean near Savannah, ı. It is navigable to Augusta, which is at the fall line.

Seneca River is formed by the junction of Little and Keowee rivers, ›out 5 miles northeast of Seneca, S. C. Both of these tributaries rise the Blue Ridge in North Carolina and the northwestern part of ›uth Carolina.

Tugalo River is formed by the junction of Chattooga and Tallulah vers, which join at the western corner of Oconee County, S. C. It ›ws in a southeasterly direction, and is a part of the boundary etween Georgia and South Carolina. Chattooga River rises in Jack-›n County, N. C., and flows in a southwesterly direction along the oundary between Georgia and South Carolina. Tallulah River rises ı Macon County, N. C., and the northwestern part of Rabun County, ia., and flows in a southeasterly direction. Parts of its course are cut nrough the solid rock for hundreds of feet, forming canyons and steep luffs. Throughout its entire length the fall is very great, and at 'allulah Falls the stream drops more than 500 feet in a short distance.

Broad River joins the Savannah at the southeast corner of Elbert 'ounty, Ga. It rises in Habersham and Banks counties, and flows in a outheasterly direction to the southeast corner of Madison County, Ga., vhere the South Fork joins it. From there it flows east to Savannah River. Its drainage is from a rolling country, and there is a consid-rable amount of fall at various points. At Anthony Shoals the fall s more than 50 feet in a short distance. Above Augusta, Ga., there s much fall, which can be developed for water power. With excep-ion of the large plant at Augusta, very little of this is being used.

The following pages give the results of the data collected in this rainage during 1904.

TALLULAH RIVER AT TALLULAH FALLS, GA.

This station was originally established August 29, 1900, by M. R. lall, and records of gage heights were obtained until October 19, 900, when the observer left Tallulah Falls. The record was resumed anuary 18, 1901, and maintained until December 31, 1901. The sta-ion was reestablished July 10, 1904, on which date bench marks were letermined and regular gage readings begun. It is located at the vagon bridge, about one-fourth mile above the falls and about the ame distance from the village of Tallulah Falls, Ga. The gage is a 'ertical rod 10 feet long, graduated to feet and tenths, spiked to a mall maple tree on the left bank of the river about 50 feet above the ›ridge. It is read once each day by J. T. McKay, who is paid by the Georgia Geological Survey. Discharge measurements are made from

the iron wagon bridge, which has a single span of 100 feet and rests on timber piers. The initial point for soundings is the end of the bridge on the upstream side at the left bank. The channel is nearly straight for 300 feet above and for 200 feet below the station. The current is swift. Both banks are high, wooded, rocky bluffs, and are not subject to overflow. The bed of the stream is composed of rock, and is rough and permanent. There is but one channel at all stages. Bench mark No. 1 is the top of a large rock on the right bank, about 30 feet above the bridge. Its elevation is 7.51 feet above the zero of the gage. Bench mark No. 2 is a white paint mark on the downstream rail of the bridge, marked "U. S. 1445." Its elevation is 33.87 feet above the zero of the gage.

Discharge measurements of Tallulah River at Tallulah Falls, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 16	W. E. Hall	51	430	1.14	1.65	490
May 12	do	56	429	1.20	1.86	516
June 11	J. M. Giles	55	385	0.79	1.20	306
June 13	do	56	404	.73	1.05	295
July 15	M. R. Hall	56	354	.51	.70	181
August 22	W. E. Hall	53	360	.63	.92	233
August 23	do	53	357	.61	.80	218
September 29	A. T. Mitchelson	55	330	.44	.50	145
October 28	M. R. Hall	52	327	.38	.40	125
October 28	do	52	321	.40	.41	127
November 23	W. E. Hall	53	354	.48	.77	171
November 23	do	53	349	.48	.75	169

Mean daily gage height, in feet, of Tallulah River at Tallulah Falls, Ga., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.9	0.9	0.5	0.4	0.7	17	0.7	1.4	0.7	0.4	0.5	[illegible]
2	.....	1.3	.8	.5	.4	.7	18	.7	1.3	.6	.4	.5	[illegible]
3	.....	1.0	.8	.5	.6	.8	19	.7	1.1	.6	.4	.5	[illegible]
4	.....	.9	1.8	.5	1.0	.8	20	.6	1.5	.7	.4	.5	[illegible]
5	.....	.9	1.5	.5	.9	1.9	21	.6	1.0	.6	.4	.5	[illegible]
6	.....	1.0	1.0	.5	.6	1.7	22	.6	.9	.6	.4	.6	[illegible]
7	.....	2.5	.8	.5	.6	1.1	23	.7	.8	.6	.4	.6	[illegible]
8	.....	2.5	.8	.5	.5	.9	24	.7	1.0	.6	.4	.6	[illegible]
9	.....	1.6	.8	.5	.5	.8	25	1.2	1.4	.6	.4	.6	[illegible]
10	.....	1.7	.7	.5	.5	.8	26	.8	1.2	.6		.5	[illegible]
11	.....	2.6	.8	.5	.5	.7	27	.7	1.7	.6	.5	.5	[illegible]
12	.....	2.0	.7	.5	.5	.7	28	.7	1.5	.7	.5	.5	[illegible]
13	.....	2.9	.8	.4	.8	.7	29	.8	1.1	.6	.5	.5	[illegible]
14	.....	1.7	.8	.4	.7	.7	30	.7	.9	.5	.4	.6	[illegible]
15	.7	1.5	.7	.4	.6	.7	31	.9	.8	.....		.....	[illegible]
16	.7	1.4	.7	.4	.5	.7							

Rating table for Tallulah River at Tallulah Falls, Ga., from July 15 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	125	1.10	290	1.80	575	2.50	1,000
0.50	145	1.20	320	1.90	630	2.60	1,070
0.60	165	1.30	355	2.00	685	2.70	1,145
0.70	185	1.40	395	2.10	740	2.80	1,220
0.80	210	1.50	435	2.20	800	2.90	1,300
0.90	235	1.60	480	2.30	860	3.00	1,380
1.00	260	1.70	525	2.40	930		

The above table is based upon twelve discharge measurements made during 1904. It is well defined between gage heights 0.4 feet and 2 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Tallulah River at Tallulah Falls, Ga., for 1904.

[Drainage area, 191 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
July 15–31	320	165	195	1.02	0.645
August	1,300	210	447	2.34	2.70
September	575	145	209	1.09	1.22
October	145	125	135	.707	.815
November	260	125	160	.838	.935
December	930	165	266	1.39	.160

TUGALOO RIVER NEAR MADISON, S. C.

This station was originally established July 19, 1898, at Cook's ferry and was discontinued December 31, 1901, when the ferry was moved. It was reestablished July 7, 1903, by M. R. Hall. It is located at Holcomb's ferry, 1 mile west of Madison, S. C., and 900 feet below the Southern Railway bridge. This station is about 1½ miles above the point where the old station was located. The gage consists of a vertical timber in three sections. The first section reads from 1 to 16 feet and is attached to a sycamore tree on the left bank, about 30 feet above the ferry landing. The second section reads from 16 to 22 feet and is attached to a sycamore tree on the left bank, about 18 feet above the ferry landing. The third section reads from 21 to 31 feet and is fastened to a locust tree on the left bank at the forks of the road, about 175 feet from the ferry landing. The gage is read once daily by T. A. Spencer, a farmer. Discharge measurements are made from the ferryboat, or a small boat which is held in place by a cable stretched across the river. The initial point for soundings is the side

away from the river of the windlass used for stretching the cable; it is located on the right bank. Distances are measured along the hand line which is used to pull the boat across the river.

The bed of the river is sandy and the current is moderately swift. The channel is about 160 feet wide and is fairly uniform in width and general appearance for some distance above and below, the current being moderately swift and the channel straight for 1,000 feet or more both above and below the station. The banks are both moderately high, but will overflow for about 200 feet on right bank and 250 feet on the left. Both are open and cultivated except a few trees along the edge of the river. These conditions make it possible to obtain fairly good float measurements at time of floods.

Bench mark No. 1 is a nail in a willow tree on the right bank 20 feet below the ferry landing. It is 7.00 feet above the zero of the gage. Bench mark No. 2 consists of two large nails in the locust tree to which a third section of the gage is attached. They are at an elevation of 22.00 feet above the zero of the gage. Bench mark No. 3 is a copper plug set in solid rock on the north side of the railroad 10½ feet from the north rail and about 400 feet east of the east end of the Southern Railway bridge. Its elevation is 44.27 feet above the zero of the gage. Bench mark No. 4 is the Geological Survey standard bronze tablet marked "666 Atlanta" on the right bank pier of the Southern Railway bridge. Its elevation is 35.37 feet above the zero of the gage, and 665.47 feet above sea level.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tugaloo River near Madison, S. C., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
June 24	J. M. Giles		724	2.66	4.00	1,927
July 7	M. R. Hall		704	2.38	3.69	1,677
July 9	F. A. Murray		665	2.30	3.40	1,535
July 31	do		579	1.88	2.84	1,091
August 28	do		462	1.72	2.18	798
September 24	do		420	1.70	1.94	715
October 9	J. M. Giles		473	1.96	2.23	927
1904.						
January 13	F. A. Murray	156	388	1.75	1.81	680
March 11	J. M. Giles	166	691	2.43	3.86	1,679
June 10	do	160	425	1.90	2.30	809
July 23	B. S. Drane	157	348	1.78	1.80	622
August 25	W. E. Hall	155	499	2.14	2.96	1,070
September 6	B. S. Drane	157	470	1.91	2.52	896
October 27	M. R. Hall	152	284	1.43	1.41	406

ı daily gage height, in feet, of Tugaloo River near Madison, S. C., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.70	2.00	2.70	3.35	2.70	3.30	2.40	3.70	2.35	1.60	1.40	1.50
.....	1.70	1.90	2.80	3.20	2.70	3.40	2.00	3.95	2.20	1.55	1.40	1.60
.....	1.80	1.90	2.80	3.10	2.85	2.80	2.00	2.50	2.40	1.60	1.50	1.60
.....	1.70	1.90	2.50	2.95	3.10	2.60	1.90	2.40	3.20	1.55	2.20	1.70
.....	1.60	1.90	2.50	2.90	2.90	2.40	1.80	2.40	3.20	1.50	2.20	2.00
.....	1.60	1.80	2.30	2.85	2.80	2.35	1.80	2.45	2.65	1.50	2.00	4.90
.....	1.90	2.00	13.20	4.10	2.70	2.30	1.80	7.00	2.30	1.50	1.60	2.60
.....	1.70	4.80	6.90	3.90	4.95	3.30	1.80	6.90	2.20	1.50	1.50	2.10
.....	1.60	3.00	5.00	6.10	6.50	2.50	2.10	4.10	2.20	1.50	1.50	1.90
.....	1.60	2.50	4.20	4.50	4.50	2.30	2.30	5.50	2.20	1.55	1.50	1.80
.....	1.70	2.60	3.90	4.00	3.60	2.30	2.00	6.60	2.05	1.50	1.50	1.80
.....	1.70	2.90	3.60	3.70	3.30	2.30	1.90	5.40	2.10	1.45	1.50	1.80
....	1.80	2.30	3.40	3.50	3.10	2.20	2.10	3.80	2.05	1.45	1.80	1.80
.....	1.70	2.10	3.50	3.40	3.05	2.10	1.80	3.30	2.00	1.40	2.00	1.70
.....	1.70	2.10	3.60	3.30	3.00	2.10	1.75	2.80	1.90	1.40	1.80	1.70
.....	1.60	2.10	3.30	3.20	2.90	2.10	1.70	3.00	1.85	1.40	1.60	1.65
.....	1.90	2.10	3.10	3.10	2.80	2.10	1.80	2.50	1.90	1.40	1.50	1.70
.....	2.00	2.00	3.05	3.10	2.75	2.10	1.80	2.30	1.80	1.40	1.50	1.75
.....	1.80	2.20	2.95	3.00	2.70	2.10	1.70	2.20	1.75	1.35	1.50	1.70
.....	1.80	4.40	2.85	2.90	2.60	2.50	1.60	3.80	1.75	1.35	1.50	1.65
.....	1.70	3.20	2.80	2.95	2.55	2.50	1.55	2.50	1.75	1.40	1.55	1.60
.....	5.10	9.50	5.30	2.90	2.50	2.20	2.20	2.20	1.90	1.35	1.60	1.65
.....	6.50	5.40	5.30	2.80	2.50	2.10	1.85	2.05	1.80	1.35	1.80	1.60
.....	3.40	4.20	5.80	2.80	2.45	2.00	1.75	2.20	1.70	1.35	1.70	1.60
.....	2.80	3.50	4.90	2.80	2.45	1.95	1.90	2.20	1.70	1.40	1.55	1.90
.....	2.40	3.20	4.70	2.90	2.40	1.95	2.00	2.85	1.70	1.40	1.50	2.00
.....	2.30	3.00	4.30	3.30	2.40	1.90	1.90	4.50	1.70	1.40	1.50	1.95
.....	2.20	3.00	4.00	2.90	2.30	1.90	1.70	3.60	1.65	1.40	1.50	7.00
.....	2.20	2.80	3.70	2.85	2.25	2.70	2.00	2.80	1.70	1.45	1.50	3.50
.....	2.10	.....	3.50	2.80	2.40	3.60	1.90	2.50	1.60	1.40	1.50	2.70
.....	2.00	.....	3.40	.....	5.20	.....	3.95	2.30	.....	1.40	.....	2.30

le for Tugaloo River near Madison, S. C., from January 1 to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
435	2.40	868	3.50	1,458	5.20	2,665
452	2.50	915	3.60	1,519	5.40	2,830
490	2.60	963	3.70	1,582	5.60	3,000
528	2.70	1,012	3.80	1,646	5.80	3,180
567	2.80	1,062	3.90	1,710	6.00	3,365
607	2.90	1,114	4.00	1,775	6.20	3,555
648	3.00	1,168	4.20	1,905	6.40	3,745
690	3.10	1,224	4.40	2,045	6.60	3,940
733	3.20	1,281	4.60	2,195	6.80	4,140
777	3.30	1,339	4.80	2,345	7.00	4,340
822	3.40	1,398	5.00	2,505		

The foregoing table is based upon 7 discharge measurements made during 190 It is fairly well defined between gage heights 1.50 feet and 4 feet.

Estimated monthly discharge of Tugaloo River near Madison, S. C., for 1904.

[Drainage area, 593 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth i inche
January	3,840	528	829	1.40	1.6
February	7,325	607	1,304	2.20	2.3
March	14,450	822	2,100	3.54	4.(
April	3,460	1,062	1,369	2.31	2.5
May	3,840	800	1,259	2.12	2.4
June	1,519	648	880	1.48	1.(
July	1,742	509	682	1.15	1.:
August	4,340	712	1,543	2.60	3.(
September	1,281	528	717	1.21	1.:
October	528	435	469	.791	.9
November	777	452	539	.909	1.(
December	4,340	490	830	1.40	1.(
The year	14,450	435	1,043	1.76	23.9

SAVANNAH RIVER AT AUGUSTA, GA.

Observations of river heights have been maintained since 1875 the city of Augusta at the city highway bridge. The results ha been printed in a volume entitled "Stages of Water at River Station prepared by the United States Weather Bureau. Those for 1875 1889 are given in part 3, those for 1890 to 1892 in part 4, and th for 1893 to 1895 in part 5 of this publication. The gage consists o vertical timber fastened to the pier and graduated to feet and inch Readings are made four times a day by J. M. Youngblood, kee of the city bridge, usually at 6 a. m., 12 m., 6 p. m., and 9 p. The 6 a. m. readings are those used by the Weather Bureau, but the publications of the United States Geological Survey since 1900 average of all four of the daily readings is used and is reduced to f and tenths of feet.

Discharge measurements are made from the North Augusta Bri at Thirteenth street in the city of Augusta, while the city gage located at the city bridge at Fifth street, which is about a mile bel

The North Augusta Bridge consists of three iron spans, 208 f each, with 319 feet of wooden approach on the right bank and

eet on the left. The channel is straight for a long distance above nd below and is about 560 feet wide at low water. The banks are igh, but will overflow at times under a part of the length of the pproaches and, at very high stages, for a long distance on either side f the river beyond the ends of the bridge. The bed of the river is andy and undergoes considerable change. The current is swift. Measurements are made from the downstream side of the bridge, and he initial point is the end of the iron bridge at the right bank on the lowstream side.

The gage at the city bridge, 1 mile below the measuring station, is heavy vertical timber, graduated to feet and inches, and is bolted o the first bridge pier which is in the water. It is on the side of the ier near the upstream corner, facing the right bank. The zero of he gage is the datum of all the city levels, and any city bench mark an therefore be used. A point is established on the North Augusta ridge from which to measure down with a steel tape. This is the op of the plate through which the top pipe of the bridge fencing asses, which is riveted to the right side of the intermediate post at he downstream end of the third floor beam from the right-bank end f the bridge, and at ordinary stages it is 55.00 feet above water, less he reading of the gage.

The observations at this station during 1904 have been made under he direction of M. R. Hall, district hydrographer.

Discharge measurements of Savannah River at Augusta, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
une 10	M. R. Hall		7,303	2.43	15.10	17,740
eptember 29	do		3,075	1.24	7.13	3,831
ecember 3	W. E. Hall		3,069	1.27	7.20	3,898
1904.						
ebruary 5	M. R. Hall	526	3,293	1.43	7.50	4,714
ebruary 15	W. E. Hall	534	3,978	1.69	8.70	6,714
pril 7	M. R. Hall	518	3,484	1.62	7.96	5,647
uly 14	W. E. Hall	519	2,904	1.32	6.45	3,826
ugust 10	M. R. Hall	601	13,200	4.22	24.57	55,680
ctober 9	do	522	2,387	1.29	5.77	3,068
ctober 18	do	522	1,998	1.03	5.07	2,057

Mean daily gage height,[a] in feet, of Savannah River at Augusta, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.3	8.0	8.8	8.6	7.4	9.2	6.8	7.7	7.3	5.3	5.1	5.7
2	7.2	7.9	8.6	8.6	7.5	11.2	7.5	7.1	7.0	4.8	4.8	6.0
3	7.1	7.9	8.6	8.3	7.3	9.1	6.8	8.9	7.0	5.3	5.4	6.3
4	7.2	7.7	8.7	8.2	7.3	7.9	5.8	8.6	6.2	5.2	5.4	6.0
5	7.3	7.6	8.4	8.1	7.6	7.0	6.4	10.4	9.3	4.9	5.6	7.3
6	7.2	7.7	8.1	8.0	7.5	6.9	6.0	8.6	11.1	5.0	6.3	8.4
7	7.1	7.4	10.4	7.9	7.3	7.0	5.5	8.4	10.4	5.3	6.7	12.5
8	6.8	9.0	16.3	8.2	7.0	7.5	5.6	16.3	8.1	4.7	6.5	9.8
9	7.0	11.9	16.2	9.1	8.8	8.0	5.1	24.5	7.3	3.8	6.4	8.1
10	7.0	11.2	12.6	10.1	8.9	7.1	6.2	24.5	7.0	5.5	6.0	7.7
11	7.3	14.4	10.5	9.3	8.9	6.0	7.0	19.1	6.5	5.2	5.6	7.2
12	7.4	12.7	9.7	8.7	8.0	6.0	6.9	14.3	6.7	4.1	5.5	7.3
13	7.6	10.7	9.3	8.4	7.6	6.7	6.7	11.8	6.4	5.2	5.4	7.0
14	7.4	9.2	9.1	8.2	7.5	6.6	6.3	9.6	6.3	4.6	6.6	7.1
15	7.5	8.7	9.1	8.0	7.0	6.5	5.7	9.3	6.1	4.5	6.8	7.0
16	7.5	8.6	9.4	8.0	7.1	6.4	5.4	10.3	6.1	3.8	7.0	7.0
17	7.2	8.4	9.0	7.8	7.2	6.2	4.8	10.7	5.8	5.5	6.7	6.9
18	7.5	8.2	8.4	8.0	7.0	6.0	5.6	9.1	5.5	4.3	6.3	7.4
19	7.7	8.1	8.4	8.0	7.0	5.2	5.4	8.3	5.7	4.5	5.9	7.6
20	7.6	8.9	8.2	7.9	6.8	6.5	5.5	7.6	5.5	4.3	5.4	7.1
21	7.4	11.6	8.3	7.8	6.8	6.6	5.3	10.1	5.5	5.1	6.3	7.1
22	7.6	14.6	8.5	7.7	6.5	7.1	5.2	9.0	5.6	4.2	5.8	6.8
23	13.1	18.5	9.6	7.7	6.7	7.2	5.0	7.4	5.7	3.8	5.4	6.5
24	13.4	15.7	11.1	7.5	6.6	6.7	10.1	7.1	5.6	5.5	5.9	6.3
25	11.5	12.5	13.4	7.5	6.4	6.1	7.7	6.9	5.5	4.8	6.2	6.1
26	9.4	10.6	11.9	7.6	6.4	5.4	8.7	6.8	5.7	4.8	5.9	6.4
27	8.5	9.5	10.5	7.6	6.4	6.2	7.8	9.2	5.4	4.2	5.6	6.5
28	8.2	9.1	10.4	7.9	6.4	5.7	7.6	12.5	5.5	5.4	6.2	7.8
29	8.2	9.0	9.6	7.8	5.6	5.7	9.5	12.4	5.6	5.3	5.7	9.7
30	8.0	.....	9.1	7.6	5.6	6.6	8.5	9.9	5.3	3.8	5.4	9.9
31	7.9	.....	8.8	.....	6.8	.....	6.8	8.0	.....	5.6	.....	8.3

[a] All gage heights mean of four readings per day: 6 a.m., 12 m., 6 p.m., 9 p.m.

for Savannah River at Augusta, Ga., from January 1 to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1,450	5.80	2,870	13.50	15,080	21.50	38,900
1,500	6.00	3,050	14.00	16,200	22.00	41,000
1,550	6.50	3,550	14.50	17,350	22.50	43,300
1,610	7.00	4,100	15.00	18,550	23.00	45,800
1,670	7.50	4,680	15.50	19,780	23.50	48,700
1,730	8.00	5,300	16.00	21,050	24.00	52,000
1,790	8.50	5,980	16.50	22,350	24.50	55,750
1,850	9.00	6,700	17.00	23,700	25.00	60,000
1,920	9.50	7,480	17.50	25,120	25.50	64,500
1,990	10.00	8,300	18.00	26,600	26.00	69,000
2,060	10.50	9,150	18.50	28,170	26.50	73,500
2,130	11.00	10,050	19.00	29,800	27.00	78,000
2,200	11.50	10,980	19.50	31,470	27.50	82,500
2,360	12.00	11,950	20.00	33,200	28.00	87,000
2,520	12.50	12,950	20.50	35,020		
2,690	13.00	14,000	21.00	36,900		

e table is based upon discharge measurements made during 1899–1904 well defined.

ated monthly discharge of Savannah River at Augusta, Ga., for 1904.

[Drainage area, 7,294 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	14,860	3,880	5,583	0.765	0.882
.....	28,170	4,560	9,206	1.26	1.36
.....	21,830	5,430	8,579	1.18	1.36
.....	8,470	4,680	5,512	.756	.844
.....	6,550	2,690	4,292	.588	.678
.....	10,410	2,360	4,088	.560	.625
.....	8,470	2,060	3,769	.517	.596
.....	55,750	3,880	11,710	1.61	1.86
.....	10,230	2,440	3,796	.520	.580
.....	2,690	[a] 1,450	2,079	.285	.329
.....	4,100	2,060	3,015	.413	.461
.....	10,980	2,780	4,772	.654	.754
'ear	55,750	1,450	5,533	.759	10.33

ys in October occurred on Sundays, when the mills were not running, and water was k by the dam.

CHAUGA RIVER NEAR FORT MADISON, S. C.

A station was established on Chauga River at Bryan wagon bridge, 2 miles east of Fort Madison and 1 mile above the mouth of the river, by M. R. Hall, and measurements were made during 1900 and 1901 in connection with the old station on Tugaloo River at Cooks Ferry. When the Tugaloo River station was reestablished in 1903 the Chauga River station was also reestablished as a bench-mark station. No gage has been established, but all discharge measurements are referred to a bench mark. Discharge measurements are made from the upstream side of the single-span wooden bridge. The bridge is supported by log cribs which are filled with rock and anchored to bed rock. The floor of the bridge is about 10 feet above low water. The initial point for soundings is the top of anchor bolt in upstream corner of the right bank abutment. The channel is straight for about 500 feet above the station; below, it is curved for about 50 feet, and then straight. The current is swift. The right bank is high, clean, and liable to overflow during freshets. The left bank is high, rocky, wooded, and is not subject to overflow. Floods can not be measured, as high water goes over the bridge. Bench mark No. 1 is a nail in a sycamore sapling on the left bank about 100 feet above the bridge. Bench mark No. 2 is the top of the downstream guard rail 7 feet from right bank. Its elevation is 10.00 feet. Bench mark No. 3 is a large nail driven horizontally in the center of the downstream end of the lowest cross log of the right bank crib abutment. Elevation, 4.50 feet above datum.

Discharge measurements of Chauga River near Fort Madison, S. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
June 10	J. M. Giles	39	61	1.49	0.91	91
September 5	B. S. Drane	40	87	1.64	1.20	143
October 27	M. R. Hall	37	48	1.33	.44	64

SENECA RIVER NEAR CLEMSON COLLEGE, S. C.

This station was established by M. R. Hall as a regular station on December 8, 1903, at which time a boxed chain gage was installed and the bench marks were established. A vertical gage had been put in July 19, 1903, by F. A. Murray, and records obtained from it for a portion of the time. The station is located at the iron wagon bridge about 3 miles south of Clemson College, S. C., and about 300 feet up the river from the crossing of the Blue Ridge Railroad, which is a branch of the Southern Railway. The bridge is a single span of iron, about 157 feet long, with 40 feet of trestle approach on the right bank and 70 feet on the left bank. At ordinary stages the channel is about

0 feet wide. The right bank is high and will not overflow, but the ft bank will overflow for a considerable width at a gage height of out 23 feet. The bed of the river is sandy. The current is moder- e. At low stages there is a daily fluctuation of about 1 foot in the ge heights, caused by the operation of water powers above. On is account the gage is read twice each day, and a mean of the two adings is used. The observer is M. L. Sanders.

Discharge measurements are made from the downstream side of the idge, and the initial point is the center of the tubular iron pier at e right bank downstream. The boxed chain gage is located on the wer chord on the downstream side. The 24-inch box extends from to 22 feet from the initial point. The chain is 31.82 feet long from e bottom of the weight to the marker. The vertical gage is of 2 by inch timbers in 5-foot sections, fastened to a scantling which is amped to the iron braces between the cylinders of the right bank er. Both gages are in good condition, except that mud accumulates the lower end of the vertical gage.

Bench mark No. 1 is the top of the upstream cylinder of the right ınk pier at a point marked "B. M." by chisel cuts. Its elevation is 3.95 feet above gage datum. Bench mark No. 2 is a copper plug set rock on the right bank under the railroad bridge and about 20 feet the right of the center pier. Its elevation is 10.27 feet above gage ıtum. This rock is low and has been uncovered by erosion of the ank. Bench mark No. 3 is a bench cut on the root of a hickory tree the fork of the roads about 100 feet from the right bank end of the ridge. Its elevation is 30.52 feet above gage datum.

The observations at this station during 1904 have been made under ıe direction of M. R. Hall, district hydrographer.

Discharge measurements of Seneca River near Clemson College, S. C., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
uly 10	F. A. Murray	148	748	1.85	4.54	1,388
uly 28	do	148	525	1.82	3.53	959
uly 29	do	148	538	2.00	3.56	1,077
ugust 27	do	147	434	2.00	3.14	869
eptember 23	do	134	316	1.95	2.51	616
)ctober 9	J. M. Giles	149	473	2.22	3.43	1,050
)ecember 8	W. E. Hall	131	326	1.65	2.21	539
1904.						
lanuary 14	F. A. Murray	128	336	1.78	2.23	601
lanuary 14	do	140	426	1.88	2.87	802
lanuary 28	W. E. Hall	148	529	1.94	3.41	1,027

Discharge measurements of Seneca River near Clemson College, S. C., etc.—Continued

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge
1904—Cont'd.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-fe*
March 10	J. M. Giles	148	722	2.33	5.28	1,6
March 11	do	148	653	2.29	4.76	1,4
May 11	W. E. Hall	148	488	2.00	3.43	9
June 9	J. M. Giles	147	494	1.86	3.55	9
June 9	do	147	524	1.94	3.73	1,0
July 16	B. S. Drane	142	208	1.37	1.41	
August 25	W. E. Hall	128	331	1.54	2.38	
September 6	B. S. Drane	148	487	1.90	3.40	
October 5	do	145	300	1.73	2.15	
December 6	do	150	874	2.60	6.35	2,
December 6	do	150	778	2.44	5.52	1

Mean daily gage height, in feet, of Seneca River near Clemson College, S. C., for 19

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.55	2.85	3.20	3.80	3.10	6.40	2.95	4.45	2.70	2.40	1.90
2	2.65	2.75	3.55	3.80	3.15	4.00	2.50	3.95	3.15	2.25	1.95
3	2.50	2.85	3.40	3.10	3.45	3.30	2.40	3.25	2.80	2.25	1.90
4	2.75	2.85	3.30	3.50	3.35	3.20	2.10	2.65	2.55	2.00	3.05
5	2.30	2.80	3.45	3.40	3.60	2.85	1.75	3.15	3.20	1.95	2.70
6	2.30	2.60	3.05	3.50	3.25	3.20	2.30	4.45	3.10	1.95	2.55
7	2.60	2.70	11.70	4.75	3.05	4.20	2.30	7.00	2.70	1.85	2.55
8	2.70	4.45	8.00	5.25	3.65	4.80	2.00	9.00	2.70	1.50	2.00
9	2.55	3.90	6.00	5.25	6.20	3.60	2.50	5.10	2.80	1.80	1.95
10	2.45	3.70	5.10	4.15	4.35	3.10	2.50	4.00	2.70	1.80	2.15
11	2.75	3.65	4.80	4.25	4.15	3.40	2.45	5.50	2.80	1.95	2.05
12	2.50	3.25	4.55	3.95	3.45	2.75	2.40	6.00	2.65	2.40	2.45
13	2.50	3.25	4.15	3.95	3.40	2.70	2.40	4.60	2.75	1.80	2.60
14	2.50	3.10	4.25	3.70	3.35	2.70	2.40	3.70	2.75	2.30	2.70
15	2.50	2.75	4.05	3.75	3.20	2.50	2.10	3.15	2.45	2.25	2.90
16	2.50	2.95	3.90	4.10	3.20	2.70	2.05	5.35	2.45	1.35	2.60
17	2.60	2.70	3.75	3.75	3.00	2.60	2.45	3.70	2.50	1.45	2.25
18	2.75	2.75	3.75	3.50	3.20	2.50	2.40	3.60	2.35	1.75	2.20
19	2.50	3.25	3.70	3.45	3.00	2.30	2.55	2.85	2.45	1.25	2.60
20	2.50	5.70	3.30	3.45	3.00	3.55	1.85	4.40	2.05	1.30	2.15
21	2.45	4.45	3.60	3.45	3.10	3.00	2.00	3.10	2.45	1.40	2.25
22	3.05	10.15	4.80	3.40	2.50	2.50	2.45	2.50	2.90	1.70	2.25
23	6.90	6.45	5.70	3.50	2.95	2.50	2.55	2.90	3.00	1.40	2.80
24	4.35	5.15	6.50	3.50	2.75	2.45	2.00	2.85	2.90	1.60	2.60
25	3.85	4.35	5.30	3.20	2.50	2.20	2.60	3.20	2.35	1.70	2.65
26	3.25	3.75	4.20	3.30	2.50	2.00	2.70	3.10	2.40	1.80	2.60
27	3.10	4.05	4.70	3.60	2.50	2.05	2.10	4.30	2.25	1.75	2.05
28	3.00	4.00	4.40	3.10	2.40	2.45	2.30	4.75	3.45	1.80	2.05
29	3.10	3.55	4.30	3.20	2.55	3.10	2.45	3.10	2.95	1.70	2.05
30	3.05	.....	4.10	3.50	3.10	4.10	2.40	3.15	2.90	1.45	2.05
31	2.85	.....	3.90	.....	7.00	.....	2.45	3.00	.....	1.75	.....

Rating table for Seneca River near Clemson College, S. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.40	285	2.30	544	3.20	859	4.20	1,265
1.50	310	2.40	577	3.30	897	4.40	1,351
1.60	336	2.50	610	3.40	936	4.60	1,440
1.70	363	2.60	644	3.50	975	4.80	1,530
1.80	391	2.70	678	3.60	1,015	5.00	1,620
1.90	420	2.80	713	3.70	1,055	5.50	1,870
2.00	450	2.90	749	3.80	1,096	6.00	2,120
2.10	481	3.00	785	3.90	1,138	6.50	2,395
2.20	512	3.10	822	4.00	1,180	7.00	2,670

The above table is based upon discharge measurements made during 1903 and 904. It is fairly well defined to gage height 6.4 feet. Discharges above 7-foot gage pproximate estimates.

Estimated monthly discharge of Seneca River near Clemson College, S. C., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
anuary	2,615	544	769
ebruary	4,700	644	1,162
arch	5,800	804	1,506
pril	1,745	822	1,078
ay	2,670	577	943
une	2,340	450	841
uly	767	377	557
ugust	3,920	610	1,253
eptember	956	466	683
ctober	577	250	377
ovember	804	420	564
ecember	2,148	435	741
The year	5,800	250	873

ROCKY RIVER NEAR CALHOUN FALLS, S. C.

This station was established as a bench-mark station. It is located t a highway bridge just below Swearingen's mill, about 3½ miles orthwest of Calhoun Falls, S. C. Discharge measurements are made rom the downstream side of the bridge, which is 110 feet long and upported by two timber piers. The initial point for soundings is the ight end of the downstream guard rail. The channel is curved for bout 200 feet above and straight for 300 feet below the station. The urrent is swift. Both banks are subject to overflow during high

water. The bed of the stream is composed of sand and gravel and is very changeable. The washing out and filling in of the channel prevents rating. The bench mark is the top of the downstream end of trestle cap on the left side of pier next the right bank. Its elevation is 6.00 feet above gage datum.

Discharge measurements of Rocky River near Calhoun Falls, S. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 17	J. M. Giles	60	143	1.76	1.60	251
September 7	do	91	114	1.74	2.50	198

BROAD RIVER (OF GEORGIA) NEAR CARLTON, GA.

This station was established May 27, 1897, by M. R. Hall. The gage is now maintained and the observer paid by the United States Weather Bureau. The station is located at the Seaboard Air Line Railroad bridge 3 miles east of Carlton, Ga., and 2 miles above the mouth of the South Fork. The boxed chain gage is bolted to the guard rail, with its bottom resting on the upstream end of the cross-ties. The center of the pulley is 39.5 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 54.00 feet. The observer is S. P. Powers, jr., who reads the gage once each day. Discharge measurements are made from the upstream side of the railway bridge to which the gage is attached. This is an iron deck bridge in two spans of 125 feet each, with trestle approaches 340 feet long on the left bank and 50 feet long on the right bank. The base of the rail of the track is about 51 feet above low water. The initial point for soundings is the end of the iron bridge on the right bank upstream side. The channel above and below the station is straight for 500 feet. The right bank is high and wooded and is not liable to overflow. The left bank is low for about 400 feet and is then high and rocky. It overflows at a gage height of about 16 feet. The bed of the stream is sand and gravel, and is somewhat changeable.

Bench mark No. 1 is the top of the upstream iron girder under the cross-ties at a point about 40 feet from the initial point for soundings. Its elevation is 51.00 feet above gage datum. Bench mark No. 2 is the top of the capstone of the right bank pier at a point under the upstream side of the end of the bridge. Its elevation is 30.78 feet above the gage datum. Bench mark No. 3 is a copper plug set in solid rock in the railroad cut 1,135 feet from the west end of the iron bridge, 11 feet north of the center of the track, and at about the same elevation as the bottom of the cross-ties. Its elevation above gage datum is 57.67 feet. Gage datum is 384 feet above sea level.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

ge measurements of Broad River (of Georgia) near Carlton, Ga., in 1903 and 1904.

ate.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
21	J. M. Giles	207	859	3.02	4.55	2,592
	do	185	582	2.13	3.10	1,242
	do	200	734	2.40	3.65	1,766
14	do	181	456	2.09	2.70	953
ıber 16	do	198	877	2.77	4.52	2,435
r 29	do	162	359	1.69	2.16	606
ber 8	do	172	395	1.59	2.20	628
904.						
17	J. M. Giles	181	469	1.72	2.62	809
	do	155	394	1.47	2.20	581
	do	129	250	1.20	1.48	299
ıber 6	do	175	512	1.44	2.37	737
ber 15	do	147	399	1.15	1.88	460

aily gage height, in feet, of Broad River (of Georgia) near Carlton, Ga., for 1904.

y.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	2.2	2.6	2.6	2.5	2.2	2.4	2.1	1.6	1.9	1.5	1.6	1.9
	2.2	2.5	2.6	2.5	2.2	2.5	2.0	2.6	1.9	1.5	1.6	2.0
	2.3	2.4	2.8	2.5	2.1	2.1	1.9	2.4	1.8	1.5	1.7	2.5
	2.3	2.4	2.8	2.4	2.1	2.0	1.8	2.0	2.4	1.5	1.9	2.1
	2.2	2.3	2.6	2.4	2.1	1.9	1.7	1.9	3.2	1.5	2.1	2.4
	2.2	2.3	2.6	2.4	2.1	1.9	1.7	2.8	2.8	1.5	2.0	4.2
	2.2	2.5	3.7	2.6	2.2	2.1	1.6	2.5	2.7	1.5	1.8	3.2
	2.2	3.4	5.7	2.6	2.2	2.2	1.6	6.5	2.1	1.5	1.7	2.6
	2.2	3.1	4.8	2.7	3.5	1.9	4.2	10.4	2.0	1.5	1.7	2.4
	2.2	3.0	3.4	2.5	3.0	1.9	2.7	6.3	1.9	1.5	1.6	2.2
	2.3	3.3	3.0	2.5	2.4	1.8	2.0	4.2	1.8	1.5	1.6	2.3
	2.3	3.0	2.8	2.4	2.2	1.8	2.0	3.3	1.8	1.5	1.6	2.1
	2.4	2.7	2.7	2.4	2.2	1.8	2.0	3.0	1.8	1.5	2.0	2.0
	2.4	2.6	2.9	2.3	2.1	1.8	1.8	2.7	1.7	1.5	2.2	2.0
	2.3	2.6	3.0	2.3	2.1	1.7	1.7	2.5	1.7	1.5	2.0	2.0
	2.2	2.5	2.8	2.3	2.1	1.7	1.6	2.6	1.7	1.5	1.9	2.0
	2.3	2.5	2.7	2.4	2.0	1.7	2.1	2.4	1.6	1.5	1.9	2.0
	2.5	2.4	2.6	2.4	2.0	1.6	1.8	2.2	1.6	1.5	1.8	2.0
	2.4	2.4	2.6	2.3	2.0	1.8	1.6	2.1	1.6	1.5	1.8	2.0
	2.2	3.6	2.5	2.3	2.0	1.7	1.5	4.2	1.6	1.5	1.7	1.9
	2.2	3.3	2.5	2.4	1.9	2.5	1.5	2.9	1.6	1.5	1.7	1.9
	2.2	4.8	4.0	2.3	1.9	2.1	1.6	2.1	2.1	1.5	1.7	1.9
	3.8	4.6	3.4	2.3	1.9	2.0	1.9	2.0	1.6	1.5	1.9	1.9
	3.2	3.7	4.3	2.2	1.9	1.7	1.8	1.9	1.6	1.5	2.3	1.9
	2.7	3.4	3.5	2.2	1.8	1.7	1.6	1.9	1.6	1.5	2.0	2.0
	2.5	2.9	3.3	2.3	1.8	1.6	2.6	1.9	1.6	1.6	1.9	2.1
	2.4	2.8	3.0	2.4	1.8	1.6	1.9	3.1	1.6	1.7	1.8	2.1
	2.4	2.7	2.9	2.3	1.8	1.6	1.7	3.3	1.6	1.7	1.8	3.3
	2.5	2.6	2.7	2.2	1.8	1.9	3.0	2.9	1.6	1.6	1.7	3.0
	2.6	.....	2.6	2.2	3.0	2.3	1.8	2.2	1.5	1.6	1.7	2.5
	2.5	.....	2.6	.....	3.1	.....	1.6	2.0	.....	1.6	.....	2.3

Rating table for Broad River (of Georgia) near Carlton, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	305	2.70	920	3.80	1,770	5.80	3,840
1.60	340	2.80	990	3.90	1,860	6.00	4,100
1.70	380	2.90	1,060	4.00	1,950	6.50	4,750
1.80	420	3.00	1,130	4.20	2,130	7.00	5,400
1.90	460	3.10	1,200	4.40	2,320	7.50	6,100
2.00	510	3.20	1,280	4.60	2,520	8.00	6,800
2.10	560	3.30	1,360	4.80	2,720	8.50	7,500
2.20	610	3.40	1,440	5.00	2,920	9.00	8,200
2.30	670	3.50	1,520	5.20	3,140	9.50	8,950
2.40	730	3.60	1,600	5.40	3,360	10.00	9,700
2.50	790	3.70	1,680	5.60	3,600	10.50	10,450
2.60	850						

The above table is based upon discharge measurements made during 1900–1904. It is well defined between gage heights 1.5 feet and 5.3 feet. Above this latter point the curve is based on one measurement at 9.1 feet.

Estimated monthly discharge of Broad River (of Georgia) near Carlton, Ga., for 1904.

[Drainage area, 762 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,770	610	741	0.972	1.12
February	2,720	670	1,113	1.46	1.58
March	3,720	790	1,247	1.64	1.89
April	920	610	720	.945	1.05
May	1,520	420	629	.825	.951
June	790	340	478	.627	.700
July	2,130	305	522	.685	.790
August	10,300	340	1,409	1.85	2.13
September	1,280	305	471	.618	.690
October	380	305	314	.412	.475
November	670	340	434	.570	.636
December	2,130	460	688	.903	1.04
The year	10,300	305	730	.959	13.05

BROAD RIVER (SOUTH FORK) NEAR CARLTON, GA.

This station was established as a bench-mark station. It is located Bull Rat Rock, about 1 mile south of Carlton, Ga. Discharge easurements are made at a shoal about 100 yards above the rock by eans of a boat. The initial point for soundings is a small sweet gum ee on the left bank. The channel is curved for 200 feet above and 0 feet below the station. The current is sluggish. The right ank is cultivated, and the left is wooded. Both banks are subject to verflow at rare intervals. The bed of the stream is composed of ck and is very rough. The bench mark is composed of three copper nails driven into the gum tree, which forms the initial point for unding. Its elevation is 5.00 feet above datum.

Discharge measurements of Broad River (South Fork) near Carlton, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
uly 20	J. M. Giles	100	179	0.36	1.00	64
eptember 7	do	105	158	.73	1.20	115

MISCELLANEOUS MEASUREMENTS IN SAVANNAH RIVER DRAINAGE BASIN.

The following is a list of miscellaneous discharge measurements made in Savannah River drainage basin during 1904:

Keowee River near Calhoun, S. C.—Keowee River is tributary to Seneca River from the north near Seneca, S. C. A measurement was made January 16 from the Lawrence Bridge, 5 miles northwest of Calhoun. The bench mark is the top of the upstream end of the first iron cross bream from the right bank, 27.00 feet above the datum of the gage.

Width, 144 feet; area, 620 square feet; mean velocity, 1.11 feet per second; gage height, 2.91 feet; discharge, 691 second-feet.

Tiger Creek at Wiley, Ga.—This stream is tributary to Tallulah River from the north, entering near Tallulah Falls, Ga. A measurement was made June 13 from the railroad trestle, one-fourth mile northwest of Wiley.

Width, 14 feet; area, 11 square feet; mean velocity, 1.12 feet per second; discharge, 12.3 second-feet.

Broad River (South Fork) near Comer, Ga.—A measurement was made March 16 at the Seaboard Air Line Railroad bridge, 1½ miles west of Comer. The bench mark is the top of the girder at sounding point 30. Its elevation is 49.00 feet above the datum of the gage.

Width, 74 feet; area, 68 square feet; mean velocity, 1.56 feet per second; gage height, 1.18 feet; discharge, 106 second-feet.

Broad River (South Fork) near Carlton, Ga.—A measurement w made May 4 at the foot of the shoals below Watson's mill.

Width, 50 feet; area, 81 square feet; mean velocity, 1.28 feet per second; dischar 104 second-feet.

The gage at Carlton read 2.20 feet.

Clouds Creek near Carlton, Ga.—This stream is tributary to Bro River. A measurement was made May 4 below the ford on the pub road one-half mile east of Watson's mill, near Carlton.

Width, 36 feet; area, 36 square feet; mean velocity, 1 foot per second; dischar 36 second-feet.

The gage at Carlton read 2.20 feet.

OGEECHEE RIVER DRAINAGE BASIN.

Ogeechee River is formed by the junction of Williamsons Swa Creek and Rocky Comfort Creek in Jefferson County, Ga., and dra a small basin in southeastern Georgia lying between the Savannah a Altamaha basins. Ogeechee River flows in a southeasterly direct and empties into the Atlantic Ocean. Its main tributary is Cannooc River, which rises in Emanuel County, Ga., flows southeast, and jo the Ogeechee about 20 miles from the Atlantic Ocean. The stre in this basin flow through a country that is mostly low. The curr is generally good, but the fall available for power is probably sm The bank on one side or the other of the stream is generally low a swampy.

The following pages give the results of the data collected in t drainage during 1904:

WILLIAMSONS SWAMP CREEK AT DAVISBORO, GA.

This station was established June 19, 1903, by F. A. Murray. I located at the Davisboro Bridge, about 200 yards south of the Cen of Georgia Railroad station, which is in the middle of the town. gage is a vertical 1 by 3 inch wooden rod 10 feet long, graduate feet and tenths with notches and numbered with brass figures. rod is nailed to the left side of the upstream post of the bent wl supports the bridge at a point 302 feet from the initial point soundings. The gage is read once each day by A. Baker, a hotel p prietor, who is paid by the Georgia Geological Survey. Discha measurements are made from the upstream side of the wooden h way bridge, which is supported by wooden bents about 18 feet ap The initial point for soundings is the outer edge of the post wl supports the end of the hand rail on the left bank upstream sid the bridge. The channel is straight for about 200 feet above and be the station. The right bank is low and overflows at a gage readin

o 4½ feet. The left bank will overflow at a gage height of 3 feet. ıe bed of the stream is sandy and is slightly shifting. There is but e channel at all stages. The current is somewhat obstructed by the nts which support the bridge at low water and by trees and brush ı the banks at high water.

Bench mark No. 1 is the top of the bridge floor at the bent 302 feet om the initial point for soundings on the upstream side of the bridge. he point is marked with a cross and the letters "B. M." cut into the ıp of the bridge-floor plank. Its elevation is 11.00 feet above the zero ' the gage, which is attached to the same bent. Bench mark No. 2 is ıe center of a large wire nail driven horizontally in an ash tree which ands in the creek near the right bank about 40 feet below the bridge. he nail is on the side of the tree toward the bridge and is at an eleva- on of 5.50 feet above the zero of the gage. Bench mark No. 3 is the ınter of a large wire nail driven horizontally in a small cypress tree ı the right bank about 45 feet below the bridge. The nail is on the de of the tree toward the bridge and is at an elevation of 5.50 feet ove the zero of the gage. The nails for both bench marks are iven within about one-half inch of the wood, from which the bark ıs been removed. This station was discontinued on December 31, 04.

The observations at this station during 1904 have been made under e direction of M. R. Hall, district hydrographer.

Discharge measurements of Williamsons Swamp Creek at Davisboro, Ga., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Square feet.	*Feet per sec.*	*Feet.*	*Second-feet.*
ıne 19	F. A. Murray	104	0.80	2.41	83
ıly 18	do	123	.81	2.58	100
ıly 29	M. R. Hall	60	.77	1.64	46
ıly 29	do	43	1.05	1.64	45
ctober 13	F. A. Murray	62	.75	1.72	47
ctober 13	do	64	.64	1.64	41
ovember 21	do	124	.76	2.58	94
ecember 28	do	133	.73	2.69	97

Mean daily gage height, in feet, of Williamsons Swamp Creek at Davisboro, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	2.80	2.80	2.50	1.80	3.10	2.20	4.60	2.20	1.65	1.40	2.10
2	2.60	2.90	2.70	2.70	1.80	3.10	1.30	4.60	2.10	1.50	1.40	2.10
3	2.50	2.60	2.60	2.40	1.85	2.30	1.40	2.30	2.00	1.50	2.00	4.00
4	2.40	2.50	3.40	2.25	1.90	1.90	1.30	1.80	2.00	1.80	2.90	3.10
5	2.50	2.60	3.20	2.30	1.55	1.45	1.30	3.80	2.05	1.70	2.90	1.70
6	2.50	2.60	3.10	2.40	1.60	1.40	1.30	3.60	2.05	1.60	2.40	1.60
7	2.50	3.20	4.10	2.45	1.80	1.30	1.30	3.80	2.10	1.60	2.20	1.20
8	2.50	3.10	3.60	2.20	1.90	3.40	1.35	3.85	2.00	1.70	2.10	1.60
9	2.50	3.30	3.40	2.90	1.80	2.00	1.35	5.35	2.00	1.60	2.00	2.10
10	2.50	4.20	3.20	2.70	1.80	1.60	2.70	5.50	2.00	1.45	1.90	2.00
11	2.70	5.10	3.10	2.60	1.80	1.60	2.00	4.00	2.00	1.50	1.80	2.00
12	2.80	3.80	3.10	2.30	1.65	1.60	1.70	2.80	2.00	1.50	1.80	2.00
13	2.60	3.50	2.80	2.25	1.55	1.50	1.50	2.60	2.00	1.40	2.20	2.00
14	2.60	3.70	2.70	2.30	1.45	1.50	1.40	2.40	1.95	1.50	3.60	2.30
15	2.90	3.50	3.20	2.25	1.65	1.50	1.50	2.40	1.90	1.50	3.00	2.70
16	2.70	3.50	2.80	2.20	1.60	1.40	1.35	2.20	1.85	1.50	2.10	1.20
17	2.60	3.30	2.50	2.10	1.50	1.40	1.30	2.05	1.80	1.40	2.20	1.00
18	2.50	3.10	2.40	2.00	1.50	1.40	1.80	2.00	1.80	1.50	2.00	2.10
19	2.60	3.10	2.70	2.10	1.45	1.35	1.60	1.90	1.80	1.50	2.00	2.10
20	2.70	3.10	2.60	2.10	1.40	1.30	1.50	1.80	1.80	1.40	2.00	2.10
21	2.80	3.70	2.90	2.05	1.40	1.30	1.20	1.80	1.70	1.60	2.00	2.00
22	2.90	4.00	2.60	2.00	1.40	1.40	1.40	1.80	1.70	1.50	2.00	2.00
23	4.20	3.70	2.60	2.00	1.25	1.25	1.50	1.90	1.75	1.40	2.60	2.00
24	3.90	3.30	2.60	2.00	1.60	1.20	1.85	1.80	1.80	1.40	2.80	2.00
25	3.00	3.00	3.00	1.90	1.30	1.20	1.45	1.80	1.80	1.40	2.80	2.00
26	2.80	3.10	2.90	2.00	1.25	1.20	2.50	1.70	1.80	1.70	2.60	2.50
27	2.80	3.10	3.40	2.00	1.25	1.20	1.80	5.10	1.70	1.50	2.30	2.50
28	3.00	3.00	3.30	2.00	1.25	1.10	1.60	5.00	1.80	1.40	2.20	2.60
29	3.00	2.90	2.50	1.95	1.30	1.50	2.50	3.60	1.60	1.40	2.20	2.60
30	2.90	.....	2.50	1.90	1.60	1.55	2.25	2.50	1.60	1.40	2.40	3.00
31	2.90	.....	2.60	.....	3.00	.....	2.10	2.30	.....	1.40	.....	2.80

CANNOOCHEE RIVER NEAR GROVELAND, GA.

This station was established June 12, 1903, by F. A. Murray. It is located at Moody's bridge, 3 miles south of Groveland, Bryan County, Ga. The original gage, reading from 0 to 17 feet, is nailed to the right side of the upstream post of the fourth bent from the left bank. From 17 to 20 feet the post is graduated to feet and half feet with nails and brass figures. A new gage consisting of two 5-foot sections of notched gage rod, reading from 0 to 10 feet is fastened with lag screws to the left bank side of upstream post of the third bent from left bank, this being the first bent in water at ordinary stage. A third section of the gage, reading from 5 to 10 feet, is fastened to a gum tree on the left bank 25 feet above the bridge. This gage faces the bridge and is used for the stages which it covers. The observer is J. M. Edwards, who reads the gage once each day. He is paid by the Georgia Geological Survey. Discharge measurements are made from the downstream side of the 9-span wooden highway bridge. The initial point for soundings is the outer edge of the post which supports the

f the hand rail of the downstream side of the bridge on the left

The channel is straight for about 300 feet above and for about eet below the station. The current is swift in the main channel luggish near the banks. Both banks are of clay and sand and low at from 15 to 16 feet gage height. The bed of the stream is t and is shifting. There is but one channel at all stages up to eight at which the river overflows its banks.

nch mark No. 1 is the top of the bridge floor at the fourth bent the left end of the bridge on the upstream side opposite a point et from the initial point for soundings. The point is marked by ss and the letters B. M. cut in the floor. It is at an elevation of feet above the zero of the gage. Bench mark No. 2 is a spike in e tree which stands near the upstream side of the road 15 feet the left end of the bridge and 9 feet upstream from the line of lge of the bridge. It is at an elevation of 20.12 feet above the of the gage. Bench mark No. 3 consists of two large wire nails n into the tree to which the third section of the gage is fastened gage height of 5.30 feet. Two more nails are also driven at the t mark.

e observations at this station during 1904 have been made under irection of M. R. Hall, district hydrographer.

harge measurements of Cannoochee River near Groveland, Ga., in 1903 and 1904.

Date.	Hydrograper.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
12	F. A. Murray	132	1,492	2.32	12.90	3,467
23	do	101	560	1.31	5.20	734
7	do	110	1,077	2.06	9.97	2,224
7	do	104	1,049	2.44	9.92	2,562
t 21	do	141	1,821	2.26	15.11	4,125
er 9	do	95	480	.96	4.45	462
nber 18	do	96	526	1.39	5.05	734
nber 29	do	105	603	1.68	6.20	1,014
1904.						
ary 20	F. A. Murray	121	1,069	1.94	9.45	2,075
22	M. R. Hall	63	125	.22	1.53	27
22[a]	do	33	43	.70	1.61	30
mber 12	W. E. Hall	96	428	1.02	4.16	438
mber 12	do	96	430	1.01	4.16	435
er 29[a]	B. S. Drane	32	34	.83	1.54	29
er 29[a]	do	32	36	.85	1.54	31
mber 29	W. E. Hall	78	237	.38	2.27	91
mber 30	do	78	238	.39	2.30	93

[a] Wading 1,000 feet below bridge.

Mean daily gage height, in feet, of Cannoochee River near Groveland, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.2	9.3	9.6	5.9	2.4	2.0	1.7	4.5	6.2	2.1	1.5	2.2
2	7.6	8.5	9.1	5.7	2.4	2.0	1.7	4.6	6.4	2.0	1.5	2.2
3	7.6	8.2	8.2	5.2	2.3	2.0	1.7	5.9	6.2	1.9	1.6	2.1
4	6.9	7.6	8.0	4.7	2.2	2.0	1.7	4.9	4.8	1.9	1.8	2.2
5	6.5	7.0	7.6	4.3	2.2	2.0	1.6	5.9	4.1	1.9	2.1	2.4
6	6.1	6.8	7.6	4.2	2.1	2.0	1.6	8.0	3.8	1.8	2.1	2.4
7	5.7	6.6	7.6	4.0	2.1	1.9	1.6	10.8	5.0	1.8	2.0	2.7
8	5.3	6.2	8.0	4.0	2.1	1.9	1.6	13.2	6.8	1.7	2.0	2.8
9	5.2	6.3	8.0	4.0	2.0	1.9	1.6	14.2	6.0	1.7	2.0	2.9
10	5.1	7.6	8.1	4.4	2.0	1.9	1.6	14.2	4.7	1.7	2.0	2.8
11	4.9	12.5	7.6	4.8	2.0	1.9	1.9	13.7	4.1	1.7	1.9	2.8
12	5.2	14.5	7.7	5.0	2.0	1.8	1.9	11.0	4.1	1.7	1.9	2.8
13	5.2	15.4	7.4	5.2	2.0	1.8	1.9	9.9	3.9	1.6	2.0	2.8
14	5.2	15.3	7.1	5.3	2.0	1.7	2.1	8.9	3.5	1.6	2.5	2.7
15	5.0	14.5	7.1	5.1	2.0	1.7	2.0	7.9	3.2	1.6	2.7	2.6
16	5.0	13.7	6.9	4.8	2.0	1.7	1.8	6.9	3.0	1.6	2.6	2.4
17	5.0	13.7	6.7	4.3	1.9	1.6	1.7	6.0	2.9	1.7	2.5	2.4
18	4.7	11.5	6.4	3.8	1.8	1.6	1.6	5.3	2.8	1.7	2.5	2.5
19	4.5	10.2	6.2	3.5	1.8	1.6	1.6	4.8	2.9	1.7	2.5	2.6
20	4.4	9.5	6.0	3.0	1.7	1.6	1.6	4.6	2.5	1.7	2.5	2.6
21	4.4	9.2	5.8	3.2	1.7	1.7	1.6	4.4	2.4	1.7	2.3	2.4
22	4.0	10.0	5.5	3.4	1.7	1.8	1.5	4.2	2.4	1.6	2.2	2.4
23	5.5	11.5	5.3	3.6	1.7	1.9	1.8	4.0	2.7	1.6	2.2	2.7
24	9.7	12.3	5.2	3.0	1.6	1.9	2.0	3.8	3.0	1.6	2.2	2.4
25	11.6	13.7	5.9	2.8	1.6	1.9	2.2	3.9	2.7	1.6	2.3	2.3
26	12.7	12.5	6.8	2.6	1.6	1.9	2.4	4.2	2.6	1.6	2.4	2.2
27	13.4	11.7	7.2	2.5	1.6	1.9	2.2	4.5	2.5	1.5	2.4	2.2
28	12.2	10.2	8.0	2.5	1.6	1.8	2.0	4.9	2.4	1.5	2.2	2.2
29	11.0	9.8	7.6	2.5	1.9	1.8	2.0	5.2	2.3	1.5	2.2	2.4
30	10.5	.....	6.9	2.3	1.8	1.8	1.9	5.6	2.2	1.5	2.2	2.5
31	9.8	.....	6.3	.....	1.9	.....	2.3	5.9	.....	1.5	.....	2.7

Rating table for Cannoochee River near Groveland, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	30	2.50	120	3.80	360	5.80	882
1.60	36	2.60	134	4.00	405	6.00	940
1.70	42	2.70	149	4.20	453	6.50	1,090
1.80	49	2.80	165	4.40	503	7.00	1,245
1.90	57	2.90	182	4.60	554	7.50	1,405
2.00	65	3.00	200	4.80	606	8.00	1,570
2.10	74	3.10	218	5.00	660	8.50	1,740
2.20	84	3.20	237	5.20	714	9.00	1,915
2.30	95	3.40	276	5.40	769	9.50	2,095
2.40	107	3.60	317	5.60	825	10.00	2,275

The foregoing table is based upon 17 discharge measurements made during 1903–4. t is well defined between gage heights 1.5 feet and 6.2 feet. Above 10 feet the ating curve is a tangent, the difference being 75 per 0.2 feet rise in gage.

Estimated monthly discharge of Cannoochee River near Groveland, Ga., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	3,550	405	1,317
February	4,300	1,000	2,508
March	2,131	714	1,301
April	911	95	428
May	107	36	60.8
June	65	36	52.2
July	107	30	52.6
August	3,850	360	1,324
September	1,183	84	390
October	74	30	42.0
November	149	30	84.1
December	182	74	122
The year	4,300	30	640

ALTAMAHA RIVER DRAINAGE BASIN.

Altamaha River is formed by the junction of Oconee and Ocmulgee rivers, which unite at the southern boundary of Montgomery County, Ga. Ohoopee River is also a tributary and enters it, from the north side, about 50 miles below the junction of the Oconee and Ocmulgee. The Altamaha River drainage basin is entirely within the State of Georgia. The river rises in the north-central part and flows in a southeasterly direction, emptying into the Atlantic Ocean near Darien. Below the junction of the Oconee and Ocmulgee and for a long distance above, on both rivers, there is no great amount of fall. Steamboat navigation is carried on from Darien to Macon on the Ocmulgee, and to Dublin, and at times to Milledgeville, on the Oconee.

Ohoopee River rises in Washington County and flows in a southeasterly direction to the Altamaha. It flows from the low hills of southeastern Georgia into the flat pine lands. Though it has not so much fall as the more northern streams, it has considerable fall that can be developed into power.

Oconee River rises on the southern slope of the Chattahoochee Ridge, in Hall County, and joins the Middle Oconee on the southwest boundary of Clarke County. From there it flows in a southeasterly direction to the Altamaha. Apalachee River is a large tributary

which rises in Gwinnett and Walton counties and enters the Oconee near the southeastern corner of Morgan County. Little River enters the main stream at the corner of Putnam, Hancock, and Baldwin counties, about 15 miles above Milledgeville, Ga. These tributaries have much fall, and a small part of it is developed. The Oconee has a fall of 250 feet in 45 miles. It has some very large water powers available from its source down to Milledgeville, where it crosses the fall line.

Ocmulgee River, the most westerly of the main tributaries, rises in the north-central part of Georgia on the southern slope of the Chattahoochee Ridge, in Fulton, Dekalb, and Gwinnett counties. It is formed by the junction of Yellow and South rivers just south of the southern corner of Newton County. Yellow River rises in Gwinnett County and flows in a southerly direction into the Ocmulgee. South River rises in Fulton and Dekalb counties and flows in a southeasterly direction. Alcovy River joins the Ocmulgee about 5 miles below the junction of South and Yellow rivers. Towaliga River enters the Ocmulgee at about the southwest corner of Jasper County.

All these tributaries rise in and flow through a very hilly country and have a great deal of fall. Ocmulgee River has a fall of over 210 feet in 35 miles. The last fall of much size is only a few miles above Macon, Ga.

The following pages give the results of data collected in this drainage during 1904:

SOUTH RIVER NEAR LITHONIA, GA.

This station was established August 17, 1903, by F. A. Murray. The station is located a short distance above Albert Shoals, 6 miles south of Lithonia, Ga. The gage is a vertical 10-foot rod fastened to a tree on the right bank just below the bridge. It is read once each day by W. N. New, who is paid by the Georgia Geological Survey. Discharge measurements are made from the 3-span wooden highway bridge. The initial point for soundings is the end of the bridge on the right bank, upstream side. The channel above the station is nearly straight for about 300 feet, and the current is sluggish, being held back by rock ledges below the station. Below the station the channel curves slightly and the current is sluggish for about 400 feet, at which point the shoals begin. The right bank is low and overflows at a gage height of 9 or 10 feet into a second channel, which has a width at high water of about 200 feet. The left bank is high and rocky and does not overflow. The bottom is solid rock.

Bench mark No. 1 is the top of the upstream end of the first wooden floor beam from the right bank. Its elevation is 15.00 feet above the zero of the gage. Bench mark No. 2 is the center of a wire nail driven

rizontally in the upstream side of the base of a willow tree on the ft bank about 40 feet upstream from the bridge. Its elevation is 00 feet above the zero of the gage. The station was discontinued December 31, 1904.

The observations at this station during 1904 have been made under e direction of M. R. Hall, district hydrographer.

Discharge measurements of South River near Lithonia, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
ugust 17	F. A. Murray	96	294	0.61	3.55	179
ptember 10	M. R. Hall	102	279	.37	3.43	104
ptember 10[a]	do	60	81	1.48	3.46	120
ctober 5	do	100	273	.38	3.40	104
1904.						
anuary 13	M. R. Hall	103	290	.44	3.58	138
larch 7	F. A. Murray	108	382	1.44	4.20	549
larch 11	M. R. Hall	97	293	.63	3.67	185
uly 16	W. E. Hall	91	216	.26	3.22	56
ugust 9	F. A. Murray	109	446	2.62	4.90	1,172
ugust 9	do	109	416	2.24	4.60	934
ugust 10	do	109	398	2.04	4.53	812
eptember 23	M. R. Hall	102	250	.22	3.16	55
ecember 5	do	105	369	1.59	4.28	588

[a] Parkers Bridge, 1 mile above station.

Mean daily gage height, in feet, of South River near Lithonia, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.5	3.6	3.6	3.6	3.6	4.1	3.7	3.6	3.5	3.4	3.3	3.5
2	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.4	3.3	3.5
3	3.5	3.6	3.6	3.6	3.6	3.6	3.6	4.3	3.5	3.4	3.3	3.5
4	3.5	3.5	3.7	3.6	3.6	3.5	3.5	3.6	4.2	3.4	3.3	3.5
5	3.5	3.5	3.6	3.6	3.6	3.6	3.5	3.5	3.8	3.4	3.3	4.3
6	3.5	3.6	3.5	3.6	3.5	3.8	3.5	3.7	3.6	3.4	3.3	3.7
7	3.5	3.6	4.2	3.7	3.5	4.4	3.5	5.7	3.6	3.4	3.3	3.6
8	3.5	4.1	4.1	3.7	4.1	3.8	3.5	6.8	3.6	3.4	3.3	3.6
9	3.5	3.7	3.6	3.6	3.7	3.7	3.5	6.5	3.6	3.3	3.3	3.5
10	3.5	4.5	3.6	3.7	3.6	3.6	3.6	4.6	3.6	3.2	3.3	3.6
11	3.5	4.3	3.7	3.6	3.6	3.6	3.5	3.8	3.6	3.3	3.3	3.6
12	3.5	3.7	3.7	3.7	3.6	3.6	3.6	3.7	3.6	3.3	3.3	3.6
13	3.5	3.6	3.6	3.7	3.6	3.6	3.6	3.6	3.5	3.3	3.4	3.6
14	3.5	3.7	4.1	3.6	3.6	3.5	3.6	3.6	3.5	3.3	3.3	3.6
15	3.6	3.7	3.7	3.6	3.6	3.5	3.5	3.7	3.5	3.3	3.3	3.6
16	3.5	3.6	3.7	3.6	3.6	3.5	3.5	4.2	3.5	3.2	3.3	3.6
17	3.7	3.6	3.7	3.6	3.6	3.5	3.5	3.8	3.6	3.2	3.3	3.6
18	3.6	3.7	3.6	3.6	3.6	3.5	3.6	3.6	3.5	3.2	3.3	3.6
19	3.6	3.7	3.6	3.6	3.5	3.5	3.5	4.1	3.5	3.3	3.3	3.6
20	3.6	4.5	3.6	3.6	3.5	3.6	3.5	3.6	3.5	3.3	3.3	3.6
21	3.6	4.1	3.6	3.6	3.5	3.6	3.5	3.6	3.5	3.3	3.3	3.6
22	4.6	4.6	3.7	3.6	3.6	3.8	3.5	3.6	3.5	3.3	3.4	3.6
23	4.2	4.5	3.7	3.6	3.5	3.7	3.7	3.5	3.5	3.3	3.4	3.6
24	4.1	4.3	3.7	3.6	3.5	3.6	3.6	3.5	3.5	3.2	3.4	3.6
25	4.1	3.8	3.7	3.6	3.5	3.6	3.5	3.6	3.5	3.2	3.4	3.6
26	3.6	3.7	3.7	3.7	3.5	3.5	3.5	3.5	3.5	3.2	3.4	3.6
27	3.6	3.7	3.6	3.7	3.5	3.5	3.5	3.6	3.5	3.2	3.4	3.8
28	3.5	3.7	3.6	3.6	3.5	3.8	3.5	3.7	3.4	3.2	3.4	3.9
29	3.5	3.6	3.6	3.6	3.5	3.8	4.5	3.6	3.4	3.2	3.4	3.6
30	3.5	.....	3.6	3.6	3.8	3.8	3.7	3.6	3.4	3.2	3.4	3.6
31	3.5	.....	3.6	.....	4.6	.....	3.5	3.5	.....	3.2	.....	3.6

Rating table for South River near Lithonia, Ga., from August 17, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.20	55	4.10	454	5.00	1,220	5.80	2,050
3.30	77	4.20	530	5.10	1,320	5.90	2,190
3.40	100	4.30	606	5.20	1,420	6.00	2,340
3.50	130	4.40	684	5.30	1,520	6.20	2,660
3.60	168	4.50	764	5.40	1,620	6.40	3,020
3.70	214	4.60	848	5.50	1,720	6.60	3,400
3.80	266	4.70	936	5.60	1,820	6.80	3,800
3.90	322	4.80	1,025	5.70	1,930	7.00	4,200
4.00	384	4.90	1,120				

The above table is based upon 13 discharge measurements made during 1903 and 1904. It is well defined between gage heights 3.2 feet and 5 feet. The table has been extended beyond these limits.

nated monthly discharge of South River near Lithonia, Ga., for 1903 and 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1903.			
17–31	454	100	169
ıber	764	100	167
r	168	130	131
ber	848	130	178
ber	168	130	135
1904.			
y	848	130	198
ry	848	130	318
	530	130	213
	214	168	179
	848	130	189
	684	130	206
	764	130	168
	3,800	130	502
ıber	530	100	155
r	100	55	74.4
ıber	100	77	84.7
ber	606	130	186
The year	3,800	55	206

OCMULGEE RIVER NEAR FLOVILLA, GA.

station was established July 26, 1901, on Ocmulgee River at r's ferry, one-half mile below Lamar's mill and 5 miles east of lla, Ga. The object of this station was to compare the discharge e river at this point with its discharge below at Macon through w-water season.

gage consisted of a ⅞ by 5 inch by 10 foot poplar board, gradu- to feet and tenths with brass figures, staples, and tacks. The as nailed to a 16-foot pine plank, which was spiked to an ash 25 feet below the ferry landing. The tree was graduated with 1 foot apart, extending the gage up to 20 feet above datum.

gage and bench marks were washed away by a flood on Febru- 7, 1902. The station was reestablished June 18, 1903, at Lamar's , by M. R. Hall. The vertical timber gage is in three sections. first section is a 1 by 4 inch board, reading from 0 to 5 feet, l to a 2 by 6 inch scantling which is spiked to a willow tree at nouth of a small branch about 20 feet above the ferry landing e right bank. The second section, reading from 5 to 15 feet, is l to an ash tree about 60 feet from the river up the same branch.

The third section, reading from 15 to 25 feet, is attached to a cottonwood tree on bank of same branch about 200 feet from the river. No attempt was made to place this gage on the same datum of the old one. The observer is B. S. White, who reads the gage once each day. He is paid by the Georgia Geological Survey. Measurements are made from the ferryboat. The initial point for soundings is the windlass on the right bank. The channel is straight for 1,000 feet above and 5,000 feet below the station. The current is swift and regular; the right bank is high, but overflows at extreme high water. The left bank is somewhat lower. The bed of the stream is sandy and shifting, and there is but one channel.

Bench mark No 1 is a nail driven in a large cottonwood tree about 200 feet from the river on the branch on which the gage is located. Its elevation is 14.00 feet above the zero of the gage. Bench mark No. 2 is a cross in the solid rock, 100 feet uphill from the first bench mark and 140 feet north from the wagon road, at a point 250 feet west of the ferry. Its elevation is 34.24 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Ocmulgee River near Flovilla, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
August 25	F. A. Murray	206	484	1.84	1.61	893
September 29	do	207	404	1.90	1.35	771
October 13	J. M. Giles	208	414	1.69	1.10	701
November 12	M. R. Hall	210	535	2.00	1.78	1,070
December 19	J. M. Giles	215	542	1.62	1.61	879
1904.						
January 13	W. E. Hall	213	593	1.90	1.97	1,130
January 21	do	208	504	1.99	1.85	1,003
January 22	do	220	1,207	2.87	5.50	3,459
February 16	F. A. Murray	212	764	2.28	2.93	1,745
April 15	W. E. Hall	211	512	1.89	1.67	970
May 28	do	200	319	1.60	.50	511
June 17	B. S. Drane	197	305	1.52	.47	463
July 12	do	209	529	1.68	1.39	891
August 26	do	212	724	2.00	2.36	1,450
September 20	J. M. Giles	186	227	1.46	— .03	332
October 6	do	196	230	1.31	— .21	302
November 2	B. S. Drane	205	260	1.57	.03	406
December 21	W. E. Hall	208	434	1.70	.93	740

Mean daily gage height, in feet, of Ocmulgee River near Flovilla, Ga., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	2.7	0.7	−0.3	−0.3	0.6	17	4.0	0.0	−0.6	0.6	1.0
.....	2.7	.7	− .3	− .2	.6	18	2.7	.0	− .6	.5	1.0
.....	2.2	.3	− .3	.2	.8	19	1.7	.0	− .4	.4	1.0
.....	3.2	.4	− .5	.7	1.2	20	1.5	− .1	− .4	.4	.9
.....	1.5	3.7	− .3	.9	1.8	21	1.1	− .1	− .3	.2	1.0
.....	1.0	2.3	− .3	.7	4.0	22	1.2	− .1	− .3	.5	.9
.....	4.2	1.4	− .3	.6	3.8	23	.9	.4	− .3	.9	.9
.....	7.4	1.0	− .3	.4	3.0	24	1.3	.0	− .4	.5	.8
.....	10.5	.8	− .3	.3	2.0	25	.9	− .2	− .6	.4	.8
.....	11.0	.5	− .4	.1	2.8	26	2.4	− .3	− .6	.8	.7
.....	7.6	.4	− .5	.1	1.4	27	1.5	− .3	− .2	.7	1.0
.....	5.0	.3	− .3	.1	1.5	28	1.4	− .2	− .2	.4	3.5
.....	4.0	.4	− .3	.6	1.3	29	2.2	− .1	− .2	.6	3.5
.....	3.9	.3	− .3	1.1	1.0	30	1.1	− .2	− .1	.5	3.0
.....	2.0	.2	− .4	1.0	1.0	31	.9	.....	− .3	.....	1.9
.....	4.1	.2	− .4	.8	.9						

ating table for Ocmulgee River near Flovilla, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.50	225	0.70	560	1.90	1,070	4.20	2,490
− .40	250	.80	595	2.00	1,120	4.40	2,640
− .30	275	.90	630	2.20	1,225	4.60	2,790
− .20	300	1.00	670	2.40	1,335	4.80	2,940
− .10	325	1.10	710	2.60	1,450	5.00	3,090
.00	350	1.20	750	2.80	1,570	5.50	3,475
.10	375	1.30	790	3.00	1,690	6.00	3,875
.20	400	1.40	835	3.20	1,820	6.50	4,275
.30	430	1.50	880	3.40	1,950	7.00	4,675
.40	460	1.60	925	3.60	2,080	7.50	5,085
.50	490	1.70	970	3.80	2,210		
.60	525	1.80	1,020	4.00	2,350		

The above table is based upon discharge measurements made during 1903 and 904. It is well defined between gage heights 0 feet and 6 feet. The table has been xtended beyond these limits. Above 7 feet gage height estimates have been made rom logarithmic diagram.

Estimated monthly discharge of Ocmulgee River near Florilla, Ga., for 1904.

[Drainage area, 1,500 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
August	8,100	630	2,005	1.34	1.54
September	2,145	275	507	.338	.377
October	325	200	261	.174	.201
November	710	275	493	.329	.367
December	2,350	525	987	.658	.759

OCMULGEE RIVER AT MACON, GA.

Ocmulgee River rises in the north-central part of Georgia and flows in a southeasterly direction, joining the Oconee south of Mount Vernon to form Altamaha River. The drainage area has the same general features as that of the Oconee. A station was established at Macon, Ga., January 21, 1893, by the United States Weather Bureau. Discharge measurements were begun by the United States Geological Survey in 1895, and a wire gage was established on the bridge of the Macon, Dublin and Savannah Railroad, and was set on the same datum as the Weather Bureau gage. For a time gage-height records were maintained by the Geological Survey, as the Weather Bureau records were for a part of the year only and were discontinued altogether from June 30, 1897, to June 1, 1899. Since June 1, 1899, the Weather Bureau gage-height records have been taken continuously, and have been furnished to the Geological Survey.

The gage is a heavy timber graduated to feet and tenths by copper nails and is bolted to the downstream portion of the right bank stone pier of the Central of Georgia Railroad bridge. Discharge measurements are made from the downstream side of the Fifth Street Bridge, an iron bridge of two 190-foot spans, located about 500 feet above the railroad bridge to which the gage is attached. The initial point for soundings is the end of the iron hand rail of the footway at the right bank on the downstream side. The channel is straight and without obstructions, except one bridge pier. The banks are high and not subject to overflow. The bed of the river is soft and changeable. The station was a fairly good one until the spring of 1902, when the bed of the stream (which is of shifting sand) below the station changed to such an extent as to make the current very sluggish at low stages.

Bench mark No. 1 is the top of the iron rim of the sidewalk 80 feet from the initial point for soundings. Its elevation is 34.35 feet above

of the gage. It was determined by measuring down to the ırface. Bench mark No. 2 is the top of a cast-iron post at the he hand rail on the right bank, downstream side, of the Fifth ›ridge. Its elevation is 37.37 feet above the zero of the gage. ıark No. 3 is the top of the downstream side of the capstone ght bank abutment of the Central of Georgia Railroad bridge. ation is 32.30 feet above the zero of the gage. Bench mark an aluminum tablet on the wall at the west side of the door United States Government building at the Mulberry street This bench mark is marked 334 feet and has an elevation of et above the zero of the gage.

bservations at this station during 1904 have been made under ction of M. R. Hall, district hydrographer.

harge measurements of Ocmulgee River at Macon, Ga., in 1903 and 1904.

.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
6	M. R. Hall	.....	2,337	0.77	4.00	1,794
.....	J. M. Giles	.....	4,720	1.56	11.30	7,244
.....	.....do	.....	4,006	1.28	9.00	5,118
.....	E. C. Murphy ..	.....	3,652	1.20	7.88	4,385
.....	M. R. Hall	.....	4,368	1.76	11.00	7,676
.....	F. A. Murray ..	.....	4,368	1.65	11.00	7,314
.....	.....do	.....	2,115	.65	3.61	1,382
r 30 ..	.....do	.....	1,765	.57	2.55	1,022
r 30 ..	.....do	.....	1,765	.60	2.56	1,057
5.....	J. M. Giles	.....	541	1.71	2.22	926
5.....	.....do	.....	1,683	.54	2.28	915
r 13 ..	M. R. Hall	.....	1,891	.65	2.84	1,236
· 21...	J. M. Giles	.....	1,877	.67	2.88	1,264
· 21...	.....do	.....	1,923	.69	2.95	1,329
.						
17 ...	F. A. Murray ..	262	2,280	.97	4.35	2,232
.....	W. E. Hall	271	2,060	.85	3.52	1,759
.....	.....do	218	1,424	.49	1.38	703
.....	.....do	223	1,426	.44	1.29	625
.....	M. R. Hall	252	1,576	.64	1.87	1,011
.....	W. E. Hall	255	1,833	.86	3.31	1,584
r 20[a].	J. M. Giles	148	279	1.54	.30	431
[b].....	.....do	59	137	1.70	— .20	232
r 1[b] ..	B. S. Drane	63	140	2.16	— .14	302

[a] At shoals above bridge. [b] Boat at Second street.

Mean daily gage height, in feet, of Ocmulgee River at Macon, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	3.5	4.2	3.1	2.8	3.9	1.9	3.5	1.8	0.0	0.0	1.0
2	2.5	3.5	4.1	3.0	2.8	4.8	1.9	2.3	1.7	-.3	-.1	1.1
3	2.1	3.6	4.2	3.1	2.8	3.4	2.0	2.9	1.4	a-.5	.2	2.4
4	2.8	3.3	4.4	3.0	2.7	3.3	1.2	4.4	1.0	a-.8	.7	1.8
5	2.7	3.2	4.2	2.9	2.7	1.9	.9	5.3	1.0	a-1.0	1.6	2.0
6	2.6	3.1	3.8	2.8	2.6	1.7	1.7	3.4	4.7	-.2	1.5	5.1
7	2.4	3.2	6.1	3.0	2.5	1.5	1.2	2.4	3.0	.2	1.4	6.0
8	2.4	8.3	7.3	3.2	2.6	2.0	1.2	10.0	2.0	.1	.9	4.4
9	2.6	7.5	7.1	5.7	3.6	4.3	1.0	11.1	1.6	.0	.9	3.3
10	2.7	6.5	5.7	5.1	3.3	3.3	.7	15.4	1.5	-.1	.8	2.5
11	3.1	10.3	5.1	3.9	3.7	2.0	1.0	13.0	1.4	.0	.8	2.2
12	3.3	9.7	4.6	3.1	3.0	1.5	1.0	9.7	1.3	-.1		
13	3.2	7.9	4.2	3.2	2.8	1.3	1.9	6.7	1.3	-.1		2.0
14	3.2	6.1	4.1	3.1	2.7	1.1	1.7	3.7	1.1	.1	1.	
15	3.3	5.2	4.2	3.0	2.6	1.0	1.7	6.7	1.0	-.1	1.	
16	3.2	4.8	5.0	2.9	2.5	1.0	1.2	5.4	1.0	-.2	1.	2.0
17	3.5	4.5	4.3	3.0	2.4	.9	1.0	5.3	.9	-.3	1.	1.9
18	4.5	4.2	3.9	2.8	2.3	.9	1.1	4.9	.8	-.1	.0	2.0
19	4.2	3.8	3.7	2.8	2.2	1.1	1.4	3.5	.8	-.3	.9	1.8
20	3.5	4.1	3.7	3.0	2.1	.9	1.9	2.5	.7	-.3	1.0	1.8
21	3.2	5.8	3.6	3.0	2.0	.8	1.3	2.0	.5	.0	.9	1.7
22	3.1	7.0	3.4	2.9	1.9	4.3	1.3	1.8	1.7	-.3	.9	1.5
23	12.9	10.3	3.6	2.9	1.8	3.4	1.1	1.7	.6	-.2	1.0	1.4
24	10.2	9.3	3.9	2.9	1.7	2.0	1.4	1.7	.9	.4	1.5	1.4
25	6.9	7.2	4.0	2.9	1.6	1.4	2.7	7.0	.6	.2	2.1	1.5
26	5.0	5.4	3.7	2.8	1.6	1.0	2.2	5.3	.4	.3	1.8	1.7
27	4.3	5.2	3.6	2.8	1.5	.8	1.2	6.3	.3	.3	1.3	2.0
28	3.8	4.7	3.8	3.0	1.4	.8	1.1	4.8	.3	.2	1.2	6.4
29	3.7	4.3	4.3	3.0	1.3	1.3	.8	3.3	.2	.0	1.0	5.5
30	3.6	.....	3.2	2.9	1.3	3.0	1.7	2.9	1	.1	1.0	4.7
31	3.5	.....	3.0	.....	1.8	.....	4.6	2.0	.....	-.1	.....	3.3

a See footnote to estimated monthly discharge.

Rating table for Ocmulgee River at Macon, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
-0.30	250	0.70	480	1.70	810	3.40	1,660
-.20	270	.80	510	1.80	850	3.60	1,770
-.10	290	.90	540	1.90	895	3.80	1,890
.00	310	1.00	570	2.00	940	4.00	2,010
.10	330	1.10	600	2.20	1,030	4.20	2,130
.20	350	1.20	630	2.40	1,130	4.40	2,250
.30	375	1.30	665	2.60	1,230	4.60	2,370
.40	400	1.40	700	2.80	1,330	4.80	2,490
.50	425	1.50	735	3.00	1,440	5.00	2,610
.60	450	1.60	770	3.20	1,550		

ie foregoing table is based upon 9 discharge measurements made during 1904. It ell defined between gage heights −0.3 foot and 5 feet. For gage heights above 5 the discharge has been estimated from 1903 measurements.

Estimated monthly discharge of Ocmulgee River at Macon, Ga., for 1904.

[Drainage area, 2,425 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
uary	9,480	985	2,064	0.851	0.981
ruary	6,540	1,495	3,149	1.30	1.40
ch	4,100	1,440	2,214	.913	1.05
il	3,050	1,330	1,535	.633	.706
y	1,830	665	1,120	.462	.533
e	2,490	510	1,029	.424	.473
y	2,370	480	772	.318	.367
gust	12,600	810	2,967	1.22	1.41
tember	2,430	330	671	.277	.309
ober[a]	400	250	300	.124	.143
ember	985	290	602	.248	.277
ember	3,505	570	1,295	.534	.616
The year	12,600	250	1,476	.609	8.26

age heights from October 3 to 5 are considered too low to represent the true mean. The mini- n discharge for the month has been assumed to apply for those days.

ALCOVY RIVER NEAR COVINGTON, GA.

This station was established on April 30, 1901. It is located about miles east of Covington, at a low wooden bridge which is often under ter. The gage is a vertical rod 10 feet long, graduated to feet and ths, marked by V-shaped grooves cut into the face of rod and brass ures. It is spiked to a birch tree on the left bank of the river 2 t from the upstream side of the bridge. The observer is Stephen lcher, a farmer living near, who is paid by the Georgia Geological rvey. Discharge measurements are made from the upstream side a low, two-span, wooden bridge about 100 feet long. The initial nt for soundings is the end of the bridge floor on the left bank, stream side. The banks are low and liable to overflow. The ground the right bank is low and swampy for several hundred yards and is ded by a moderate rise. The bed of the stream is sandy and shift- , and the water is sluggish at low stages.

Bench mark No. 1 is a notch and nail in a maple tree on the right k, about 15 feet from the upper side of the bridge. Its elevation .91 feet above the zero of the gage. Bench mark No. 2 is a copper

plug set in the solid rock on the north edge of the side ditch on the upstream side of the road, 100 feet from the end of the bridge, on the left bank of the river. Its elevation is 7.82 feet above the zero of the gage. This station was discontinued on December 31, 1904.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Alcovy River near Covington, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 11	M. R. Hall		518	1.11	4.41	575
May 28	do		465	.83	3.48	385
July 24	do		352	.49	1.92	174
August 27	do		334	.38	1.60	127
October 8	do		306	.39	1.50	120
November 14	F. A. Murray		334	.47	1.90	157
December 19	do		344	.45	1.85	155
1904.						
February 20	W. E. Hall	71	470	.88	3.67	415
April 13	M. R. Hall	60	320	.63	2.11	202
June 16	do	59	230	.29	.63	68
July 12	W. E. Hall	57	254	.37	1.00	94
September 22	M. R. Hall	60	207	.26	.45	53
September 22 [a]	do	24	26	1.61	.45	42
September 22 [b]	do	30	33	1.27	.45	42
December 6	do	67	392	.84	3.35	328
December 6	do	67	396	.90	3.38	358

[a] 200 feet below bridge. [b] 300 feet above bridge.

ı daily gage height, in feet, of Alcovy River near Covington, Ga., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	2.00	2.60	2.90	2.40	2.10	2.90	1.25	0.80	1.15	0.25	0.55	1.10
.....	2.90	2.50	2.80	2.40	1.90	2.40	1.15	1.20	1.00	.45	.65	1.40
.....	2.00	2.40	2.90	2.50	1.80	2.30	.80	3.65	.80	.30	.80	1.50
.....	2.20	2.30	3.00	2.40	1.70	1.50	.60	1.85	1.30	.20	1.30	1.70
.....	2.40	2.20	2.90	2.00	1.70	1.30	.60	1.45	2.50	.20	1.45	2.50
.....	2.30	2.20	2.60	2.00	1.70	1.50	.50	1.30	1.70	.20	1.55	3.40
.....	2.20	2.50	4.00	2.50	1.50	1.40	.40	2.80	1.15	.35	1.35	3.45
.....	2.10	2.70	4.50	3.00	2.50	1.50	.75	3.10	1.00	.30	.95	3.40
.....	2.20	2.80	4.90	3.70	2.20	1.50	1.75	4.40	1.10	.35	.95	2.40
.....	2.20	3.50	4.60	2.90	2.60	1.50	1.70	4.80	1.00	.30	.90	2.30
.....	2.30	5.50	4.00	2.50	2.90	1.30	1.65	5.70	1.00	.30	.85	2.20
.....	2.50	5.00	3.30	2.30	2.00	1.20	1.60	5.90	.75	.30	.85	2.25
.....	2.40	4.50	3.00	2.10	1.90	1.10	1.00	4.75	.80	.25	1.50	2.00
.....	2.60	4.10	3.00	2.00	1.40	1.00	1.20	3.30	.75	.25	1.45	1.95
.....	2.30	3.80	3.50	2.00	1.40	.90	.90	3.10	.75	.25	1.30	1.70
.....	2.10	3.60	3.60	2.00	1.50	.80	.75	4.90	.70	.25	1.35	1.70
.....	2.50	3.20	3.20	2.00	1.40	.60	.70	4.75	.50	.25	1.20	1.80
.....	2.70	3.00	3.00	2.00	1.50	.60	.50	2.80	.65	.25	1.10	1.70
.....	2.60	3.40	2.80	2.00	1.30	.50	.60	2.00	.60	.25	1.05	1.70
.....	2.40	3.70	2.50	2.00	1.30	.40	.70	1.80	.50	.30	1.10	1.60
.....	3.40	4.20	2.50	2.10	1.30	.40	.90	1.70	.45	.25	1.15	1.60
.....	3.50	4.70	2.90	2.10	1.30	.70	.50	1.40	.40	.25	1.10	1.50
.....	4.50	5.00	3.10	2.00	1.20	.60	.70	1.20	.30	.25	1.60	1.50
.....	4.10	4.70	3.10	2.10	1.20	.50	.80	1.20	.30	.25	1.80	1.50
.....	3.50	4.40	2.90	2.00	1.10	.50	.70	1.20	.50	.90	2.15	1.75
.....	3.00	3.90	2.80	2.20	1.10	.50	.60	1.10	.45	.85	2.00	1.85
.....	2.90	3.40	2.80	2.20	1.10	.45	.50	1.15	.40	.75	1.50	1.80
.....	2.70	3.20	2.70	2.20	1.10	.40	.40	1.70	.35	.65	1.30	2.10
.....	2.60	3.00	2.50	2.00	1.00	.75	.60	1.40	.30	.65	1.20	2.60
.....	2.50	.....	2.30	1.90	1.00	1.30	.50	1.25	.30	.65	1.20	2.90
.....	2.90	.....	2.30	.....	2.00	.....	.70	1.10	.....	.65	.....	2.75

le for Alcovy River near Covington, Ga., from January 1 to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
38	1.50	135	2.70	259	3.90	460
45	1.60	144	2.80	272	4.00	480
52	1.70	153	2.90	286	4.20	522
59	1.80	162	3.00	300	4.40	564
66	1.90	171	3.10	315	4.60	606
73	2.00	180	3.20	331	4.80	648
80	2.10	190	3.30	347	5.00	690
87	2.20	201	3.40	364	5.20	734
95	2.30	212	3.50	382	5.40	778
103	2.40	223	3.60	401	5.60	822
111	2.50	234	3.70	420	5.80	866
119	2.60	246	3.80	440	6.00	910
127						

The foregoing table is based upon nine discharge measurements made during 1904. It is well defined between gage heights 0.0 and 4 feet. Above 4 feet the curve is determined by two measurements made in 1902 and 1903.

Estimated monthly discharge of Alcovy River near Covington, Ga., for 1904.

[Drainage area, 228 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	585	180	264	1.16	1.34
February	800	201	406	1.78	1.92
March	669	212	331	1.45	1.67
April	420	171	209	.917	1.02
May	286	95	147	.645	.74
June	286	52	105	.460	.513
July	157	52	84.2	.369	.425
August	888	80	290	1.27	1.46
September	234	45	80.8	.354	.395
October	87	38	50.6	.222	.256
November	195	63	115	.504	.562
December	373	103	193	.846	.975
The year	888	38	190	.831	11.28

APALACHEE RIVER NEAR BUCKHEAD, GA.

This station was established February 13, 1901, by M. R. Hall. It is located at the iron wagon bridge over Apalachee River about 3½ miles north of the town of Buckhead, Ga. The bridge is a single span 103 feet long, supported by tubular piers. Its trestle approaches are about 500 feet long on the right bank and about 100 feet on the left. At ordinary stages the channel is about 80 feet wide, and it is only slightly curved above and below the bridge. The bed of the river is part rock and part sand. The current is moderately swift and is somewhat broken and irregular on account of ruins of old pier bases about 50 feet upstream. The right bank is low for a distance of 400 feet and will overflow at a gage height of 10 feet. The low portion is thickly covered with trees and a brushy growth, which will greatly retard the flood water passing over it. The left bank is high and will not overflow, except to a short distance up the steep slope. Measurements are made from the downstream side of the bridge, and the initial point is the outside edge of the iron pier, left bank, downstream. The original gage was graduated to feet and tenths with brass figures and staples, and consisted of two parts. The first section, extending from zero to 10 feet, was fastened to a small ash tree

the left bank about 100 feet below the bridge. The second section, tending from 6 to 20 feet, was nailed to the upstream post of the t wooden bent next to the iron bridge, on the right bank.

On March 22, 1905, a standard chain gage was attached to the stream side of the bridge, in the third panel from the right bank. e length of the chain from the end of the weight to the marker is 70 feet.

Bench mark No. 1 is the top of the iron pier from the right bank, vnstream side. Its elevation is 25.00 feet above the zero of the gage. ich mark No. 2 is the top of the downstream end of the first floor .m from the right bank. Its elevation is 25.50 feet above the zero the gage. Bench mark No. 3 is a copper plug set in solid rock 10 t west of the upstream tubular pier on right bank and 3 feet stream from the line of the upper edge of the bridge. Its elevation 3.73 feet above the zero of the gage.

The observer is G. A. J. Adams, a farmer living about one-third of nile from the bridge. Readings are made once a day, except for ee months during low water, when they were made twice a day. e observer is paid by the Georgia Geological Survey.

The observations at this station during 1904 have been made under direction of M. R. Hall, district hydrographer.

Discharge measurements of Apalachee River near Buckhead, Ga.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
uary 15	M. R. Hall		290	1.53	2.33	444
y 27	do		222	1.63	1.88	361
e 12	do		327	1.97	3.07	643
y 25	do		204	1.30	1.51	266
gust 28	do		198	1.08	1.31	214
ober 9	do		211	1.12	1.45	237
ember 1	do		231	1.10	1.60	255
1904.						
rch 19	M. R. Hall	85	279	1.67	2.39	466
y 12	do	73	260	1.20	1.83	311
y 13	W. E. Hall	75	244	.91	1.48	223
gust 9	M. R. Hall	95	771	2.43	7.15	1,877
gust 9	do	95	785	2.42	7.30	1,903
tember 21	do	73	180	.70	.90	128
ober 13	W. E. Hall	70	166	.55	.80	91
ober 13	do	70	166	.57	.80	94
ember 26	M. R. Hall	77	232	.80	1.39	186
ember 26	do	77	227	.74	1.34	167

Mean daily gage height, in feet, of Apalachee River near Buckhead, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	1.90	2.40	2.20	1.90	2.30	2.00	1.70	1.50	0.65	0.95	1.40
2	1.80	1.80	2.50	2.40	1.50	2.10	1.80	1.90	1.50	.65	1.25	1.50
3	1.90	1.80	2.50	2.20	1.80	1.50	1.30	2.10	1.40	a .50	1.20	1.90
4	1.80	1.90	2.40	2.10	1.90	1.30	1.40	3.00	1.60	.65	1.90	1.65
5	1.70	2.00	2.30	2.00	1.60	1.50	1.30	2.70	2.80	.65	1.85	2.25
6	1.70	2.10	2.40	2.00	1.70	1.40	1.20	2.40	2.30	.65	1.50	2.75
7	1.60	2.10	3.60	2.20	1.80	1.30	1.10	3.00	1.90	.75	a 1.00	3.55
8	1.60	3.10	5.70	2.80	1.90	2.90	1.00	4.50	1.70	.80	1.45	2.65
9	1.50	4.00	4.80	4.00	2.00	2.40	3.00	5.70	1.60	.65	1.40	2.15
10	1.80	4.50	3.40	2.90	2.50	1.90	1.90	9.90	1.40	a .45	1.25	1.90
11	1.90	7.00	3.00	2.40	2.10	1.60	1.80	6.70	1.30	.65	1.35	1.80
12	1.90	6.50	2.80	2.30	2.00	1.60	1.70	6.40	1.30	.65	1.35	1.80
13	2.00	5.50	2.50	2.30	1.80	1.50	1.60	2.50	1.40	.60	1.90	1.75
14	2.00	3.10	2.30	2.20	1.70	1.50	1.50	2.60	1.40	.60	1.80	1.70
15	2.00	3.00	3.50	2.10	1.90	1.40	1.40	2.80	1.30	.65	1.85	1.70
16	2.00	2.80	3.30	2.00	1.80	1.40	1.20	3.50	1.20	.65	1.75	1.90
17	2.20	2.40	2.80	1.90	1.80	1.30	1.00	4.50	1.00	a .45	1.70	1.80
18	2.10	2.20	2.60	2.00	1.80	1.30	.80	2.60	.85	.55	1.70	2.00
19	2.10	2.50	2.40	2.10	1.70	1.00	1.00	2.80	a .65	.65	1.65	1.80
20	2.00	3.30	2.30	2.20	1.70	.70	1.20	2.00	.80	.65	1.45	1.90
21	2.10	4.00	2.20	2.30	1.60	2.00	1.00	1.70	.80	.65	a 1.00	1.80
22	2.20	5.10	3.00	2.20	1.50	1.70	1.60	1.50	.80	.65	1.45	1.70
23	6.00	6.80	3.20	2.10	1.50	1.50	1.60	2.00	.75	.60	1.75	1.70
24	6.50	5.00	3.10	2.00	1.40	1.40	2.00	2.10	.75	a .40	1.65	1.60
25	2.70	3.50	2.90	1.90	1.40	1.30	1.20	2.30	.75	.70	1.70	1.50
26	2.50	3.00	2.70	2.10	1.40	1.30	1.60	2.00	a .55	.85	1.50	1.60
27	2.40	2.80	3.00	2.20	1.30	1.20	1.50	1.70	.60	1.40	1.45	1.60
28	2.40	2.60	2.70	2.30	1.30	1.20	1.50	2.00	1.05	1.05	a 1.25	3.00
29	2.30	2.50	2.50	2.20	1.30	1.60	1.60	1.70	.90	.90	1.50	3.30
30	2.00	.....	2.40	2.10	1.20	2.50	1.60	1.60	.75	.95	1.45	2.50
31	2.00	.....	2.30	.....	1.80	.....	1.50	1.60	.....	a .65	.....	2.30

a During low water in September, October, and November the Monday gage heights are lower than natural flow on account of storing water during Sunday at High Shoals Factory 25 miles above this station.

Rating table for Apalachee River near Buckhead, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	43	1.20	174	2.00	358	3.60	791
.50	55	1.30	195	2.20	409	3.80	849
.60	69	1.40	216	2.40	461	4.00	907
.70	84	1.50	238	2.60	514	4.20	965
.80	100	1.60	261	2.80	568	4.40	1,025
.90	117	1.70	284	3.00	622	4.60	1,085
1.00	135	1.80	308	3.20	678	4.80	1,145
1.10	154	1.90	333	3.40	734	5.00	1,205

The above table is based upon 26 discharge measurements made during 1901-1904. It is well defined between gage heights 0.8 foot and 3 feet and fairly well from gage

eights 3 to 8 feet. Above gage height 4.2 feet the rating curve is a tangent, the difference being 30 per tenth.

Estimated monthly discharge of Apalachee River near Buckhead, Ga., for 1904.

[Drainage area, 440 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,655	238	438	0.995	1.15
February	1,805	308	751	1.71	1.84
March	1,415	409	596	1.35	1.56
April	907	333	425	.966	1.08
May	487	174	286	.650	.749
June	595	84	264	.600	.669
July	622	100	239	.543	.626
August	2,675	238	647	1.47	1.70
September	568	[a]62	187	.425	.474
October	216	[a]43	84.1	.191	.220
November	333	[a]126	240	.545	.608
December	776	216	363	.825	.951
The year	2,675	43	377	.856	11.00

[a] See note under gage heights.

OCONEE RIVER NEAR GREENSBORO, GA.

This station was established July 25, 1903, by M. R. Hall. It is ocated at the new wagon bridge, about 5 miles west of Greensboro, n the road to Madison, Ga. The bridge is of two spans. The first ne from the right bank is 80 feet long, and is not over the water xcept at time of floods. The main span over river is 144 feet long. here is also 52 feet of iron trestle and about 40 feet of wooden trestle n the right bank, and 253 feet of iron trestle and about 325 feet of ooden trestle on the left bank. Ordinarily the river is about 120 eet wide. The bed is sandy and shifting. The channel is nearly raight, and the current is regular and sluggish at low stages. The ght bank is high and rocky, with the exception of a low bench under e bridge and approach. The left bank is low and will overflow at gage height of 12 to 15 feet to the end of the approach, a distance about 600 feet, and extreme high water may pass beyond the end the approach.

Discharge measurements are made from the downstream side of e bridge. The initial point is the end of the iron trestle on the ght bank, downstream.

The boxed chain gage is bolted to the lower chord of the downstream side of the bridge 163 to 165 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 38.73 feet. The gage is read once each day by M. A. Stevens, who is paid by the Georgia Geological Survey.

Bench mark No. 1 is the top of the downstream end of the second floor beam from the right-bank pier. Its elevation is 36.00 feet above gage datum. Bench mark No. 2 is a copper plug set in the rock under the upstream side of the bridge opposite a point 84 feet from the initial point for soundings. Its elevation is 13.55 feet above gage datum. Bench mark No. 3 is on a hickory tree 26 feet downstream from the end of the wooden trestle on the right bank. Its elevation is 33.15 feet above gage datum. Bench mark No. 4 is the concrete foundation under the iron post below the initial point for soundings. Its elevation is 27.58 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Oconee River near Greensboro, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
June 12	M. R. Hall		808	1.88	4.00	1,521
July 25	do		439	1.67	1.75	733
August 28	do		439	1.51	1.70	665
October 9	do		424	1.63	1.70	690
December 2	W. E. Hall		389	1.86	1.66	725
1904.						
February 19	W. E. Hall	117	525	2.03	2.75	1,066
March 19	M. R. Hall	117	544	1.86	2.75	1,023
May 12	do	113	404	1.86	1.90	753
June 9	do	115	368	1.68	1.57	617
July 13	W. E. Hall	115	326	1.40	.99	455
August 9	M. R. Hall	131	1,409	3.56	9.82	5,017
August 9	do	133	1,504	3.61	10.49	5,435
September 21	do	94	295	1.01	.45	297
September 21	do	94	291	1.03	.45	301
October 13	W. E. Hall	93	285	1.06	.51	302
October 13	do	93	285	1.02	.50	291
November 26	M. R. Hall	103	320	1.63	1.35	523
November 26	do	103	308	1.60	1.28	494

Mean daily gage height, in feet, of Oconee River near Greensboro, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.8	2.0	3.1	2.6	1.8	3.1	2.5	2.6	1.5	0.4	0.7	1.4
2	1.8	2.2	2.8	2.6	1.8	2.6	1.7	2.7	1.5	.3	.8	1.4
3	2.0	2.3	3.0	2.4	1.7	2.0	1.5	2.4	1.7	.3	.8	1.8
4	1.8	2.4	3.4	2.3	1.5	1.4	1.0	2.0	2.0	.4	1.2	1.7
5	1.8	2.5	3.4	2.3	1.5	1.2	.9	1.4	3.8	.6	1.3	1.9
6	1.6	2.5	3.4	2.2	1.6	1.0	.9	3.4	2.8	.5	1.0	4.4
7	1.7	2.3	6.0	2.7	1.6	1.0	.8	3.2	1.9	.4	.9	4.7
8	1.8	5.1	7.9	2.8	1.6	1.8	.8	3.7	1.8	.4	.9	2.8
9	1.8	5.5	7.6	3.8	1.7	1.3	1.1	9.3	1.2	.3	.7	2.2
10	1.9	4.0	4.3	3.0	1.8	1.2	1.0	11.9	1.0	.2	.6	1.9
11	2.0	8.5	3.8	2.5	4.5	1.1	1.7	10.0	1.0	.6	.6	2.0
12	2.0	6.2	3.6	2.4	2.0	2.3	1.5	5.3	.9	.6	.6	2.0
13	2.1	4.2	3.4	2.2	2.0	1.3	1.1	3.8	.9	.5	1.6	1.8
14	2.0	3.9	3.1	2.1	1.8	1.2	.9	2.8	.9	.5	1.4	1.7
15	2.0	3.3	4.8	2.2	1.8	1.1	.8	2.4	.8	.2	1.2	1.7
16	1.9	3.2	3.5	2.1	1.7	.9	.7	3.9	.7	.1	1.2	1.5
17	2.5	2.8	3.2	2.2	1.8	.9	.7	2.7	.7	.2	1.2	1.8
18	2.0	2.7	2.8	2.2	1.6	1.0	.7	2.1	.6	.2	1.1	1.8
19	2.0	3.0	2.7	2.3	1.5	.9	.7	1.7	.6	.4	1.1	1.7
20	1.8	4.7	2.5	2.0	1.3	.7	.7	1.6	.6	.4	1.0	1.7
21	2.2	4.9	2.7	2.0	1.2	1.2	.8	1.5	.5	.5	.8	1.5
22	2.0	6.7	3.7	2.0	1.2	2.1	1.7	1.6	.5	.5	.8	1.5
23	2.2	5.2	4.3	2.4	1.1	1.5	1.2	1.5	.5	.6	1.0	1.5
24	4.7	4.8	3.7	2.0	1.1	1.4	1.0	1.5	.5	.1	1.5	1.4
25	4.8	4.5	3.4	2.0	1.0	1.0	1.1	1.4	.4	.1	1.8	1.2
26	3.0	4.0	3.3	2.0	1.0	1.0	1.1	1.3	.4	.2	1.4	1.2
27	2.5	3.4	3.6	3.5	.9	.9	1.0	1.8	.5	.1	1.2	1.4
28	2.4	3.4	3.1	3.0	1.0	.7	1.0	1.8	.6	.8	1.0	3.3
29	2.3	3.0	2.8	2.8	1.1	1.0	.9	1.8	.5	.6	1.0	3.8
30	2.3	.....	2.7	2.6	1.2	2.7	.8	1.6	.4	.5	1.3	2.8
31	2.1	.....	2.6	.....	2.8	.....	3.7	1.6	.....	.4	.....	2.2

NOTE.—The low water gage heights are liable to more or less error owing to the storing of water at developed powers above this station.

Rating table for Oconee River near Greensboro, Ga., from July 26, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.10	215	0.90	420	1.70	675	3.00	1,140
.20	235	1.00	450	1.80	710	3.20	1,220
.30	255	1.10	480	1.90	745	3.40	1,300
.40	280	1.20	510	2.00	780	3.60	1,384
.50	305	1.30	540	2.20	852	3.80	1,472
.60	330	1.40	570	2.40	924	4.00	1,560
.70	360	1.50	605	2.60	996		
.80	390	1.60	640	2.80	1,068		

It is based upon 18 discharge measurements made during 1903–4. It is well defined between *gage heights 0.4 foot* and 4 feet. Above 4 feet gage height, esti-

mates of daily discharge are based upon the extension of the rating curve, thr two measurements at about 10 feet gage height.

Estimated monthly discharge of Oconee River near Greensboro, Ga., for 1903 and 1

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Me
1903.			
July (26–31)	924	640	
August	7,450	605	1
September	5,244	420	1
October	710	510	
November	1,428	640	
December	924	605	
1904.			
January	1,924	640	
February	4,070	780	1
March	3,676	960	1
April	1,472	780	
May	1,780	420	
June	1,180	360	
July	1,428	360	
August	6,522	540	1
September	1,472	280	
October	390	215	
November	710	330	
December	1,876	510	
The year	6,522	215	

OCONEE RIVER AT MILLEDGEVILLE, GA.

This station was established August 22, 1903, by M. R. F although several discharge measurements were made before that ti The first one was made by C. C. Babb on October 19, 1895. bench mark to which the present gage is referred was used to get water height at the time of each of these measurements.

The station is located at the iron highway bridge in the eastern of Milledgeville, which consists of four spans, 100 feet, 150 feet, feet, and 80 feet long, beginning at the right bank end, and sl wooden trestles about 25 feet long at each end.

At low water the river is about 300 feet wide, including two pi and often a sand bar of considerable extent in the third span. bar sometimes practically stops the third-span channel, leaving river about 200 feet wide. The bed is sandy and shifting, and

water is shallow and swift. These conditions are unfavorable to accurate measurements as well as a constant rating. The channel is only slightly curved. Both banks are high and will not overflow. Measurements are made from the downstream side of the bridge, and the initial point is the end of the iron bridge at the right bank, downstream. The gage is read once daily by J. A. Brooks, who was paid by the Georgia Geological Survey until June 30, but has since that time been paid by the United States Weather Bureau.

Bench mark No. 1 is the top of the third floor beam from the pier on the east bank, downstream end. It is 39.00 feet above gage datum.

The gage established during August, 1904, is a boxed chain gage of the 24-inch box type, fastened to a horizontal timber, which is bolted at each end to the intermediate posts on the upstream side of the third panel of the third span from right bank. The bottom of the gage box is 43.80 feet above datum, and the length of chain is 45.80 feet. The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Oconee River at Milledgeville, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
August 22	M. R. Hall	299	1,022	2.24	3.95	2,301
September 11	do	282	604	1.89	2.39	1,141
September 12	do	270	570	1.83	2.27	1,042
October 16	F. A. Murray	264	607	1.87	2.39	1,140
December 16	do	293	821	2.31	3.05	1,908
December 18	do	292	738	2.33	2.74	1,720
1904.						
February 17	W. E. Hall	302	1,237	2.31	3.99	2,852
February 18	do	299	1,135	2.16	3.71	2,449
May 25	do	226	484	1.71	1.47	827
May 26	do	251	501	1.71	1.47	857
June 10	M. R. Hall	292	660	1.84	2.04	1,213
June 28	W. E. Hall	211	453	1.55	1.12	703
June 28	do	211	469	1.53	1.14	723
August 18	do	299	1,135	1.99	3.40	2,256
September 19	M. R. Hall	262	427	1.44	.95	628
October 11	W. E. Hall	197	304	1.10	.37	335
October 11	do	199	305	1.18	.41	361
October 12	do	209	341	1.20	.49	410

Mean daily gage height, in feet, of Oconee River at Milledgeville, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.90	3.40	3.90	3.20	2.50	3.55	2.40	4.60	1.80	0.60	0.60	1.[illegible]
2	2.85	3.40	3.90	3.50	2.40	3.65	2.35	2.90	1.40	.50	.60	1.[illegible]
3	2.80	3.20	3.80	3.20	2.35	2.65	2.10	2.80	1.40	.50	.70	2.[illegible]
4	2.80	3.20	3.80	3.10	2.40	2.20	1.80	3.60	1.30	.90	1.10	2.[illegible]
5	2.80	3.10	3.80	2.90	2.30	1.80	1.60	2.80	1.30	.60	1.70	2.[illegible]
6	2.75	3.10	3.40	3.00	2.10	1.55	1.50	2.40	2.70	.50	1.[illegible]	3.[illegible]
7	2.75	3.10	4.40	3.10	2.10	1.65	1.40	4.60	2.50	.50	1.50	4.[illegible]
8	2.75	5.20	6.40	3.40	2.10	2.25	1.20	[a]11.60	2.20	.50	1.50	4.[illegible]
9	2.75	5.20	7.40	3.70	2.10	2.75	1.20	7.20	1.80	.40	1.40	2.[illegible]
10	2.95	5.40	6.10	4.40	2.30	2.20	1.70	9.20	1.60	.80	1.30	2.[illegible]
11	2.95	9.50	4.70	3.60	3.50	1.70	2.20	11.60	1.30	.40	1.10	2.[illegible]
12	2.90	9.00	4.20	3.40	2.30	1.60	4.20	7.10	1.30	.50	1.30	2.[illegible]
13	3.00	6.70	3.90	3.00	2.20	2.10	2.10	5.20	1.30	.50	1.50	2.[illegible]
14	3.10	5.10	3.70	2.90	2.10	1.70	1.80	3.40	1.10	.50	1.80	2.[illegible]
15	3.10	4.60	3.90	2.75	2.10	1.50	1.40	2.80	1.20	.30	2.00	2.[illegible]
16	3.00	4.40	4.70	2.70	2.10	1.45	1.30	7.30	1.00	.20	1.80	2.[illegible]
17	3.00	4.00	4.00	2.70	2.10	1.45	1.10	5.50	1.20	.70	1.60	2.[illegible]
18	4.20	3.80	3.50	2.70	2.00	1.20	1.20	4.10	.90	.20	1.40	2.[illegible]
19	3.50	3.60	3.50	2.75	1.95	1.20	1.00	3.30	1.00	.20	1.30	2.[illegible]
20	3.40	3.60	3.40	2.70	1.80	1.10	1.20	2.70	.90	.30	1.20	2.[illegible]
21	3.10	3.70	3.30	2.70	1.75	1.00	.90	2.10	1.00	.30	1.10	2.[illegible]
22	3.20	6.90	3.80	2.65	1.75	1.40	1.00	1.90	1.00	.40	1.30	1.[illegible]
23	11.50	9.40	3.90	2.70	1.70	2.65	.60	1.80	.70	.40	1.40	1.[illegible]
24	8.95	8.10	6.10	2.75	1.65	2.00	1.50	1.60	.80	.40	1.50	1.[illegible]
25	5.70	6.30	6.20	2.60	1.60	1.65	1.80	2.10	.60	.30	1.70	1.[illegible]
26	4.50	5.10	4.60	2.50	1.45	1.40	2.40	1.90	.60	.30	1.90	1.[illegible]
27	3.80	4.40	4.10	2.75	1.25	1.40	1.80	2.10	.60	.30	1.60	1.[illegible]
28	3.60	4.10	4.30	2.85	1.45	1.10	1.40	2.60	.50	.60	1.30	5.[illegible]
29	3.60	4.10	3.80	2.75	1.45	2.00	1.40	2.10	.50	.80	1.20	4.[illegible]
30	3.60	.....	3.40	2.60	1.60	1.80	1.40	2.00	.40	.70	1.40	3.[illegible]
31	3.40	.....	3.30	.....	2.55	.....	2.40	1.80	.....	.70	.....	3.[illegible]

[a] This height is doubtful.

NOTE.—Owing to the irregular running of the mill above this station during the low-water period the true mean gage height was not always obtained, although two readings were made each day. From this cause the gage heights below 0.5 foot are probably too low and in some cases gage heights above 0.5 foot may be artificially high.

Rating table for Oconee River at Milledgeville, Ga., from August 25, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.20	290	1.00	630	1.70	1,010	2.80	1,760
.30	330	1.10	680	1.80	1,070	3.00	1,920
.40	370	1.20	730	1.90	1,130	3.20	2,090
.50	410	1.30	785	2.00	1,190	3.40	2,265
.60	450	1.40	840	2.20	1,320	3.60	2,450
.70	495	1.50	895	2.40	1,460	3.80	2,640
.80	540	1.60	950	2.60	1,610	4.00	2,840
.90	585						

The foregoing table is based upon twelve discharge measurements made during 04. It is well defined between gage heights 0.2 foot and 4 feet. Above 4-feet gage ight, daily discharge estimates are based on a tangent, the difference being 105 per nth.

Estimated monthly discharge of Oconee River at Milledgeville, Ga., for 1903 and 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1903.			
ugust 25–31	2,090	1,573	1,823
eptember	16,800	1,255	2,998
ctober	4,625	1,320	1,702
ovember	2,740	1,573	1,872
ecember	2,740	1,648	1,911
1904.			
anuary	10,720	1,723	2,643
ebruary	8,615	2,005	3,903
arch	6,410	2,175	3,152
pril	3,260	1,535	1,926
ay	2,355	758	1,229
une	2,498	630	1,138
ly	3,050	450	1,019
ugust	10,820	950	3,138
eptember	1,685	370	755
ctober	585	[a] 290	403
ovember	1,190	450	840
ecember	4,310	785	1,638
The year	10,820	290	1,815

[a] See note under gage heights.

OCONEE RIVER AT DUBLIN, GA.

Oconee River rises in the northern part of Georgia, near Gainesville, n the southern slope of the Chattahoochee Ridge, which separates he headwaters of this stream from the tributaries of Chattahoochee iver. It flows in a southeasterly direction and joins the Ocmulgee t the southern border of Montgomery County to form the Altamaha. he drainage area is for the most part hilly and is made up of cultiated ground broken by extensive tracts of forest.

A station was established by the United States Weather Bureau in 894 at Dublin, Ga., about 60 miles above the junction of the Oconee ith the Ocmulgee. Records were kept, with the exception of the mmer months of 1896, until April 30, 1897, when the station was scontinued. In 1898 discharge measurements were commenced by

the United States Geological Survey, and on February 11 an observer was employed to read the gage. On October 15, 1898, the Weather Bureau again adopted the station and has maintained the gage and furnished gage heights to the Geological Survey continuously since that time. The present observer is R. F. Mathis, who reads the gage once daily.

The gage is a heavy timber bolted to the downstream side of the center pier of the Wrightsville and Tennille Railroad bridge in the eastern part of the city of Dublin. The bridge is a drawbridge, and the pier to which the gage is attached is the circular center pier of the turn span. The gage is graduated to feet and tenths, and the markings face toward the right bank. A secondary sloping gage is attached to a solid rock on right bank about 25 feet above the railroad bridge. This gage is graduated by chisel cuts on a 3-inch by 5-inch oak timber, and reads from −1.6 to +1.9. Measurements are made from the iron highway bridge, which is 500 feet upstream from the gage. This bridge is also a drawbridge, and consists of the turn span between two other spans of 75 feet each. The total length of bridge proper is 320 feet. On the left bank, which is low, there is 1,100 feet of iron-frame trestle approach. There is also a short trestle on the right bank, which is high. The ordinary width of the river is about 235 feet. At a gage height of about 20 feet the left bank begins to overflow, and it is practically covered to end of the approach at 25 feet. This ground is thickly covered with a brushy growth, which will no doubt cause the velocity of the water overflowing it to be small. The right bank does not overflow. The bed of the stream is of loose rock, sand, and gravel. The channel is straight and the current is swift and fairly uniform, except where it is broken by the three bridge piers. The initial point for soundings is the end of the bridge at the right bank, on the upstream side.

Bench mark No. 1 is the top of the upstream end of the floor beam on top of the first tubular pier and is 41.30 feet above the zero of the gage. Bench mark No. 2 is a point on the fifth step from the bottom at the south entrance of the court-house, 6 inches from the east end of the step. Its elevation is 82.51 feet above the zero of the gage. Bench mark No. 3 is the top of the granite water table 2½ feet west of the southeast corner of the court-house. Its elevation is 80.97 feet above the zero of the gage. Bench mark No. 4 consists of three large nails driven into a cypress tree on the right bank about 200 feet above the bridge. Its elevation is 3.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Oconee River at Dublin, Ga., in 1903 and 1904.

te.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
03.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
.....	J. M. Giles	.....	5,038	4.00	15.40	20,160
.....	.....do	.....	4,930	4.02	14.95	19,800
.....	F. A. Murray ..	.....	2,923	3.35	8.81	9,804
.....	.....do	.....	2,832	3.33	8.51	9,432
.....	.....do	.....	1,824	2.75	4.47	5,017
.....	.....do	.....	2,235	2.93	5.95	6,579
24.....	.....do	.....	1,910	2.34	4.61	4,475
6.....	.....do	.....	806	2.12	.12	1,713
ber 14...	M. R. Hall	.....	1,114	2.22	1.15	2,472
04.						
y 18....	F. A. Murray ..	248	1,998	2.57	4.33	5,136
.....	W. E. Hall	242	1,528	2.30	2.45	3,521
.....	M. R. Hall	210	729	1.11	— .98	808
ber 16..	W. E. Hall	200	750	1.12	— .90	840
ber 17..	.....do	200	732	1.09	— .95	798
27.....	B. S. Drane....	249	662	.78	—1.55	515
27.....	.....do	249	666	.84	—1.55	557
ber 3....	W. E. Hall	222	1,086	1.81	.45	1,968

Mean daily gage height, in feet, of Oconee River at Dublin, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.7	2.5	3.9	2.5	1.0	0.0	−0.1	−0.5	0.6	−1.3	−1.1	−0.5
2	1.7	2.8	3.5	2.0	1.0	.8	.2	.8	.1	−1.4	−1.2	−.5
3	1.7	2.7	3.5	2.0	1.0	2.0	.6	1.4	−.3	−1.3	−1.1	.3
4	1.6	2.7	3.9	2.0	.7	1.3	.2	.9	−.4	−1.3	−1.0	1.2
5	1.6	2.7	4.0	1.8	.7	.5	−.4	1.5	−.5	−1.3	−.8	1.2
6	1.6	2.0	3.9	1.6	.7	.3	−.6	2.4	−.5	−1.3	−.5	1.3
7	1.5	2.0	3.9	1.6	.4	.1	−.7	1.6	.4	−1.3	−.3	1.7
8	1.4	3.0	4.5	2.0	.4	.1	−.7	2.4	1.1	−1.4	−.3	2.9
9	1.4	5.0	5.5	2.0	.3	.0	−.8	5.0	.6	−1.3	−.4	3.0
10	1.6	7.0	5.5	2.7	.3	−.1	−.8	6.2	.2	−1.3	−.7	2.0
11	1.4	8.5	6.8	3.0	.3	−.3	−.9	6.5	−.1	−1.4	−.7	1.0
12	1.4	9.0	5.5	3.0	.3	−.5	−.7	6.8	−.4	−1.3	−.5	.8
13	2.0	9.9	4.0	2.0	1.0	−.1	.2	6.9	−.7	−1.4	−.5	.8
14	2.0	9.9	3.5	2.0	1.0	−.1	.3	6.6	−.7	−1.4	.3	.6
15	2.0	9.9	3.4	1.4	1.0	−.1	−.4	3.5	−.7	−1.4	−.1	.5
16	2.0	7.5	3.4	1.0	.7	−.3	−.6	1.8	−.8	−1.4	−.2	.5
17	2.0	5.5	3.4	1.0	.7	−.5	−.8	3.8	−.9	−1.4	−.1	.5
18	2.0	4.5	3.4	1.0	.7	−.5	−.9	3.3	−.9	−1.5	−.1	.5
19	3.0	4.0	3.0	1.0	.7	−.5	−1.0	3.0	−.9	−1.4	−.2	.9
20	2.8	3.5	2.9	1.0	.7	−.6	−1.0	2.0	−1.0	−1.5	−.4	.9
21	2.6	4.0	2.5	1.0	.7	−.5	−1.0	.9	−1.0	−1.5	−.4	.6
22	2.0	5.5	2.0	1.0	.4	−.5	−1.0	.4	−1.0	−1.5	−.5	.6
23	2.9	7.0	2.0	1.0	.4	−.5	−.8	.1	−1.0	−1.5	−.5	.4
24	6.6	7.8	2.9	1.0	.4	−.1	−.8	−.1	−1.1	−1.5	−.4	.3
25	7.6	8.0	3.8	1.0	.0	−.1	−.6	.1	−1.1	−1.5	−.3	.2
26	7.8	8.3	5.0	1.0	.0	−.4	−.3	.3	−1.1	−1.5	−.1	.2
27	6.9	7.0	4.5	1.0	.0	−.8	−.2	.9	−1.2	−1.4	−.1	.3
28	4.4	5.0	4.0	1.0	−.2	−.9	−.1	2.5	−1.2	−1.4	−.1	.6
29	3.6	4.0	3.8	1.0	−.2	−.8	−.4	3.0	−1.2	−1.4	−.2	2.5
30	3.2	.....	3.4	1.0	−.5	−.5	−.6	1.0	−1.2	−1.3	−.4	2.5
31	2.9	.....	3.0	.....	.0	.....	−.6	1.0	.....	−1.1	.....	2.5

Rating table for Oconee River at Dublin, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−1.50	560	−0.30	1,305	1.60	2,800	5.00	5,790
−1.40	600	−.20	1,381	1.80	2,964	5.50	6,300
−1.30	645	−.10	1,457	2.00	3,130	6.00	6,830
−1.20	695	.00	1,534	2.20	3,296	6.50	7,380
−1.10	750	.20	1,688	2.40	3,462	7.00	7,930
−1.00	810	.40	1,842	2.60	3,630	7.50	8,505
−.90	874	.60	1,998	2.80	3,799	8.00	9,090
−.80	941	.80	2,154	3.00	3,969	8.50	9,690
−.70	1,010	1.00	2,312	3.50	4,402	9.00	10,330
−.60	1,081	1.20	2,473	4.00	4,850	9.50	10,980
−.50	1,154	1.40	2,636	4.50	5,310	10.00	11,630
−.40	1,229						

ie foregoing table is based upon eight discharge measurements made during . It is fairly well defined between gage heights −1.50 feet and 4.30 feet. Above the curve is rather uncertain. The table has been extended beyond these limits.

Estimated monthly discharge of Oconee River at Dublin, Ga., for 1904.

[Drainage area, 4,182 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
ary	8,850	2,636	3,897	0.932	1.07
uary	11,500	3,130	6,599	1.58	1.70
h	7,710	3,130	4,717	1.13	1.30
l	3,969	2,312	2,766	.661	.738
	2,312	1,154	1,899	.454	.523
	3,130	874	1,449	.346	.386
	1,998	810	1,169	.280	.323
ust	7,820	1,154	3,617	.865	.997
ember	2,392	695	1,131	.270	.301
ber	750	560	609	.146	.168
ember	1,611	695	1,205	.288	.321
mber	3,969	1,154	2,329	.557	.642
The year	11,500	560	2,616	.626	8.47

OHOOPEE RIVER NEAR REIDSVILLE, GA.

'his station was established June 13, 1903, by F. A. Murray. It is ated at the wooden highway bridge, commonly known as Shepds Bridge, 4½ miles west of Reidsville. The gage is on the downam side of the middle post which supports the bridge protector. section from zero to 10 feet is two 5-foot sections of notched and nted gage fastened with lag screws to the post. From 10 to 13 t the post is graduated to feet and half feet with white paint, and m 13 to 20 feet it is graduated to feet with nails and numbered h brass figures. On November 19, 1903, a new 1 by 4 inch section et long, reading from 3 to 8 feet, was spiked to a pine plank which ecurely nailed to a cypress tree on the left bank of the river about feet above the bridge. The observer is J. D. Swain, who is paid the Georgia Geological Survey. Bench mark No. 1 is the top of cap of the fifth bent from the left end of the bridge on the upam side, opposite a point 106 feet from the initial point for ndings. It is at an elevation of 20.00 feet above the zero of the e. Bench mark No. 2 consists of two nails driven horizontally in downstream side of a cypress tree on the left bank about 120 feet

above the bridge. This bench mark is 8.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Ohoopee River near Reidsville, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
June 13	F. A. Murray		2,001	2.88	12.47	5,762
June 24	do		1,187	1.40	6.41	1,692
July 16	do		1,650	2.20	10.34	3,667
July 16	do		1,774	2.10	10.46	3,756
August 22	do		2,183	2.95	14.00	6,441
October 8	do		667	.71	2.84	476
October 8	do		635	.72	2.85	462
November 19	do		889	1.27	4.96	1,131
December 30	do		1,123	1.63	6.69	1,836
1904.						
February 19	F. A. Murray	136	1,667	2.16	10.19	3,611
April 13	W. E. Hall	115	775	1.34	4.53	1,038
July 23	M. R. Hall	112	490	.76	2.28	369
September 13	W. E. Hall	113	713	1.15	4.20	823
September 13	do	113	708	1.21	4.20	858
September 14	do	113	641	.98	3.63	628
September 15	do	113	578	.81	3.00	470
September 15	do	113	569	.80	3.00	454
October 31[a]	B. S. Drane		42	1.25	.32	52
December 1	W. E. Hall	108	423	.45	1.56	190

[a] Wading 1,000 feet above the bridge. Three narrow channels.

n daily gage height, in feet, of Ohoopee River near Reidsville, Ga., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	6.4	6.7	8.2	4.4	1.4	0.9	0.5	1.1	8.3	1.1	0.3	1.6
.....	6.6	6.4	7.8	4.8	1.4	1.6	.5	1.0	6.4	1.0	.3	1.4
.....	.....	6.0	7.3	4.1	1.3	1.8	.5	2.2	6.5	1.0	.7	1.6
.....	6.1	5.6	7.0	3.8	1.3	1.5	.6	4.6	6.0	.9	1.0	1.8
.....	6.0	5.3	7.1	3.5	1.3	1.2	1.0	6.2	5.2	.8	1.5	2.1
.....	5.4	5.0	7.1	3.3	1.1	1.1	1.2	8.4	4.3	.8	1.5	2.8
.....	4.8	4.8	7.1	3.0	1.1	1.0	1.1	9.0	4.8	.7	1.5	3.1
.....	4.6	5.0	7.4	2.9	1.0	.9	1.0	9.8	5.6	.6	1.3	3.1
.....	4.8	5.1	7.8	2.8	1.0	.7	.8	9.0	5.6	.7	1.0	3.0
.....	.....	6.0	8.0	3.8	1.0	.7	1.1	8.4	5.5	.7	.9	2.8
.....	.....	8.2	8.0	4.6	.9	.6	1.4	8.6	5.1	.7	.8	2.7
.....	.....	12.1	7.8	4.8	.9	.6	1.0	9.0	5.0	.7	.7	2.5
.....	.....	12.0	7.6	4.7	.8	.6	1.0	9.4	4.4	.6	1.0	2.5
.....	.....	.....	7.5	4.4	.8	.5	.8	8.9	3.6	.6	1.5	2.4
.....	.....	11.5	7.1	3.4	.7	.5	.6	8.6	3.1	.7	1.9	2.3
.....	.....	11.2	6.9	3.1	.7	.5	.8	8.3	2.6	.6	2.0	2.2
.....	2.6	11.0	6.6	2.8	.7	.5	.6	7.6	2.3	.6	1.8	2.2
.....	2.4	10.7	6.2	2.3	.7	.4	.5	6.3	2.1	.5	1.5	2.2
.....	2.4	10.1	5.9	2.1	.6	.4	.5	6.4	1.9	.5	1.3	2.1
.....	2.3	9.4	5.7	2.0	.6	.5	.4	5.4	1.6	.4	1.2	2.1
.....	2.3	9.3	5.3	1.9	.6	.4	.4	4.8	1.5	.4	1.1	2.0
.....	2.9	9.8	5.1	1.8	.6	.9	.6	4.5	1.5	.4	1.0	2.0
.....	3.1	10.1	4.9	1.8	.5	.8	2.3	3.9	2.1	.4	1.1	1.9
.....	4.0	10.4	4.6	1.7	.5	.6	1.9	3.7	2.2	.4	1.6	1.9
.....	4.8	10.2	4.7	1.6	.5	.6	1.7	3.9	1.9	.3	1.2	1.9
.....	5.7	9.8	4.8	1.5	.5	.5	1.5	3.9	1.7	.3	2.7	1.8
.....	6.4	9.3	4.6	1.4	.5	.5	1.5	3.9	1.5	.4	2.4	1.9
.....	7.2	.....	4.8	1.4	.5	.5	1.4	5.4	1.3	.4	2.2	2.0
.....	7.8	8.5	4.9	1.5	.9	.5	1.5	6.3	1.2	.3	1.8	2.4
.....	7.1	.....	5.0	1.5	1.1	.5	1.5	9.2	1.2	.3	1.6	2.7
.....	6.8	.....	4.6	.....	.8	.....	1.3	9.2	.....	.3	.....	2.7

able for Ohoopee River near Reidsville, Ga., from January 1 to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
50	1.60	197	3.80	690	7.00	1,950
57	1.70	213	4.00	755	7.50	2,184
65	1.80	230	4.20	824	8.00	2,430
74	1.90	247	4.40	895	8.50	2,685
83	2.00	265	4.60	968	9.00	2,950
93	2.20	302	4.80	1,043	9.50	3,222
104	2.40	341	5.00	1,120	10.00	3,500
115	2.60	382	5.20	1,198	10.50	3,800
127	2.80	425	5.40	1,277	11.00	4,120
140	3.00	470	5.60	1,357	11.50	4,460
153	3.20	519	5.80	1,438	12.00	4,820
167	3.40	572	6.00	1,520	12.50	5,198
182	3.60	629	6.50	1,728	13.00	5,590

The foregoing table is based upon nineteen discharge measurements made during 1903 and 1904. It is well defined between gage heights 0.0 foot and 11.0 feet. Above gage height 11.0 the table is determined by one measurement at 14.0 feet.

Estimated monthly discharge of Ohoopee River near Reidsville, Ga., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	2,330	321	1,062
February	4,894	1,043	2,877
March	2,531	968	1,703
April	1,043	167	495
May	167	65	101
June	230	57	91.8
July	321	57	125
August	3,388	115	1,811
September	2,582	140	747
October	127	50	74.0
November	403	50	170
December	494	167	316
The year	4,894	50	798

MISCELLANEOUS MEASUREMENTS IN ALTAMAHA RIVER DRAINAGE BASIN.

The following is a list of miscellaneous discharge measurements made in Altamaha River drainage basin during 1904:

Yellow River near Jackson, Ga.—A measurement was made October 7 at the wagon bridge, 11 miles from Jackson, on the road to Covington, Ga. The bench mark is the downstream edge of the bridge floor, 40 feet from the initial point for soundings, and is 8.00 feet above the datum of the gage.

Width, 113 feet; area, 229 square feet; mean velocity, 0.30 foot per second; gage height, 1.80 feet; discharge, 69 second-feet.

South River near Jackson, Ga.—A measurement was made October 7 at the wagon bridge, 10 miles from Jackson, on the road to Covington, Ga. The bench mark is the upstream end of floorbeam, 66 feet from the initial point for soundings, 20.00 feet above the datum of the gage.

Width, 121 feet; area, 152 square feet; mean velocity, 0.90 foot per second; gage height, 1.10 feet; discharge, 137 second-feet.

Pole Bridge Creek near Lithonia, Ga.—This stream is a tributary of South River from the left near Lithonia, Ga. A measurement was made July 16 near the mouth of the creek, on the road between New's Bridge and Parker Bridge.

Width, 15 feet; area, 7 square feet; mean velocity, 1.43 feet per second; discharge, 10 second-feet.

A measurement at the same section September 23 gave the following results:

Width, 17 feet; area, 7 square feet; mean velocity, 1.00 foot per second; discharge, second-feet.

Alcovy River near Newton Factory, Ga.—A measurement was made October 7 from the wagon bridge at Henderson's mill, 4 miles from Newton Factory, on the road to Covington, Ga. The bench mark is the upstream edge of the bridge floor, 90 feet from the initial point for soundings, 11.00 feet above the datum of the gage.

Width, 40 feet; area, 43 square feet; mean velocity, 1.46 feet per second; gage height, 1.25 feet; discharge, 62 second-feet.

Horse Creek near Lumber City, Ga.—This stream is a tributary of Ocmulgee River from the left. A measurement was made September 8, 1½ miles above the mouth of the creek, 10 miles north of Lumber City. The bench mark is a nail driven into the end of the second floorbeam above the second bent from the left bank, 15.00 feet above the zero of the gage.

Width, 55 feet; area, 115 square feet; mean velocity, 1.03 feet per second; gage height, 3.17 feet; discharge, 118 second-feet.

Little Ocmulgee River at Wilcox, Ga.—A measurement was made September 7 at the wagon bridge at Wilcox, 2½ miles upstream from Lumber City, Ga. The bench mark is the center of lag bolt driven into the end of the second floorbeam from the right bank on the downstream side, 15.00 feet above the zero of the gage.

Width, 100 feet; area, 488 square feet; mean velocity, 1.92 feet per second; gage height, 3.15 feet; discharge, 937 second-feet.

Sugar Creek at Wilcox, Ga.—A measurement was made September 7, from the Southern Railway bridge, one-fourth mile north of Wilcox. The bench mark is the top of the steel girder, upstream side, 50 feet from the right end of the trestle, 25.00 feet above the datum of the gage.

Width, 41 feet; area, 117 square feet; mean velocity, 1.06 feet per second; gage height, 7.50 feet; discharge, 124 second-feet.

Ocmee River near Milledgeville, Ga.—Measurements were made at Staley's ferry, 6 miles upstream from Milledgeville. The bench mark is a nail in an ash tree on the right bank, 100 feet above the ferry, 10.00 feet above the datum of the gage.

June 29; width, 270 feet; area, 1,310 square feet; mean velocity, 0.79 foot per second; gage height, 4.90 feet; discharge, 1,030 second-feet.
September 20; width, 207 feet; area, 1,108 square feet; mean velocity, 0.50 foot per second; gage height, 4.35 feet; discharge, 547 second-feet.

Beaverdam Creek near Greensboro, Ga.—This stream enters Oconee River from the left. A measurement was made March 19, at Veazey Ford, 6 miles south of Greensboro, on the road to Sparta, Ga. The

bench mark is a nail in a small ash tree on the left bank, 20 feet below the foot plank, 3.00 feet above the datum of the gage.

Width, 15 feet; area, 10 square feet; mean velocity, 1.70 feet per second; gage height, 1.50 feet; discharge, 17 feet.

Little River near Milledgeville, Ga.—A measurement was made from the wagon bridge, 9 miles north of Milledgeville, 1 mile above the mouth of the river. The bench mark is the top of the downstream end of the cap of left bent of the second pier from the left bank, marked by a copper brad. Its elevation is 15.00 feet above the datum of the gage.

Width, 89 feet; area, 65 square feet; mean velocity, 1.09 feet per second; gage height, 3.17 feet; discharge, 71 second-feet.

MINOR SOUTHERN ATLANTIC DRAINAGE BASINS.

MISCELLANEOUS MEASUREMENTS.

The following miscellaneous discharge measurements were made in the Satilla River drainage basin during 1904:

Satilla River near Waycross, Ga.—A measurement was made September 9, at the covered wagon bridge, 3 miles east of Waycross. The bench mark is the center of lag bolt driven into the left side of the first floorbeam from the first pier from the left bank, 20.00 feet above the datum of the gage.

Width, 108 feet; area, 1,077 square feet; mean velocity, 1.07 feet per second; gage height, 8.2 feet; discharge, 1,150 second-feet.

Hurricane Creek near Blackshear, Ga.—This stream is an important tributary of Satilla River, entering from the north. A measurement was made September 10, at Baxley's bridge, near Blackshear. The bench mark is a large nail driven into the downstream end of the floorbeam over the second pier from the right bank, 15.00 feet above the datum of the gage.

Width, 67 feet; area, 415 square feet; mean velocity, 1.35 feet per second; gage height, 6.57 feet; discharge, 562 second-feet.

APALACHICOLA RIVER DRAINAGE BASIN.

Apalachicola River is formed by the union of Flint and Chattahoochee rivers at the Georgia-Florida line. It flows in a southerly direction through Florida to the Gulf of Mexico. It is navigable, and boats run up Flint River to Albany, Ga., and up Chattahoochee River to Columbus, Ga.

Flint River rises in Fulton County, Ga., a few miles south of Atlanta. It flows in a southerly direction to Talbot County, southeasterly to Macon County, southerly to Worth County, and southwesterly to Apalachicola River. It drains the south-central portion of Georgia, extending from Atlanta south to the Florida line. The

ibutaries to Flint River are mainly large creeks with much fall. he principal ones among these are Whitewater, Whiteoak, Redoak, lkins, Big Potato, Muckalee, Kinchafoonee, Ichawaynochaway, and pring creeks.

Flint River has many good water powers on its course. Between a oint opposite Woodbury, Ga., and a point opposite Knoxville, Ga., ı Crawford County, a distance of about 45 miles, the river falls 334 eet. Very little of its power is yet developed.

Chattahoochee River rises in the Blue Ridge, in White County, and lows in a southwesterly direction until it reaches the Alabama line at he southwest corner of Troup County, Ga. From there it flows in a outherly direction, forming the western boundary of Georgia, until t flows into Apalachicola River at the southern boundary of the State. It drains almost all of the north-central, middle-west, and outhwest portions of Georgia, and has a drainage area of 4,900 square niles at Columbus, Ga., which is at the fall line.

Soque River joins the Chattahoochee on the western edge of Habersham County. This river rises in Habersham County and flows in a outhwesterly direction. It has considerable fall, dropping as much s 40 feet within a few hundred feet.

Farther down the Chattahoochee, at the west boundary of Hall County, Chestatee River enters. It rises in Lumpkin County and lows in a southerly direction through a very hilly and steep country nd has much fall all along its course.

From its source down to Columbus, Ga., Chattahoochee River is an xcellent water-power stream. From the lower edge of Lumpkin County down to Columbus, Ga., there is a fall of over 850 feet, 366 eet of this fall being between Westpoint and Columbus. All along s course there are many small tributaries flowing from a high, hilly ountry. These have much fall, and many small water powers are vailable.

The following pages give the results of the data collected at this ation during 1904:

CHATTAHOOCHEE RIVER NEAR CORNELIA, GA.

This station was established as a bench-mark station. It is located t Duncan Bridge, about 7 miles northwest of Cornelia, Ga., and 1 mile elow the mouth of Soque River. Discharge measurements are made rom the downstream side of the inclosed wooden highway bridge, the ıeter being lowered through holes cut in the floor or by raising floor lank. The initial point for soundings is the end of the bridge at the eft bank, downstream side. The channel is curved for about 500 feet bove and straight for about 800 feet below the station. The current s moderate. The right bank is clean, and overflows for about 200 feet. The left bank is high, rocky, wooded, and does not overflow. The

bed of the stream is composed of rock at the left and silt at the right bank, free from vegetation, and shifting. There is but one channel at all stages, broken by the piers of the bridge. A fish-trap dam about 800 feet below the bridge will probably affect the rating at this station. The bench mark is the top of downstream stringer at a point 59 feet from the left end of the bridge. Its elevation is 21.00 feet above datum.

Discharge measurements of Chattahoochee River near Cornelia, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
June 8	J. M. Giles	124	363	1.34	1.40	487
September 30	A. T. Mitchelson	115	364	.70	.95	253
October 29	M. R. Hall	103	319	.67	.91	215

CHATTAHOOCHEE RIVER NEAR NORCROSS, GA.

This station was established June 10, 1902, by M. R. Hall. It is located at Medlock's toll bridge, about 4½ miles north of Norcross, Ga. This point is above the mouth of Johns Creek and below the mouth of Sewannee Creek. A vertical section of gage, reading from zero to 8 feet, is attached to an oak tree on the right bank of the river, 100 feet above the bridge. A chain gage was established March 14, 1903. The center of the pulley is 28.32 feet above the zero of the gage, and the length of the chain from the end of the weight to the marker is 28.75 feet. The gage is read twice each day by W. O. Medlock, the bridge owner. He is paid by the Georgia Geological Survey. Discharge measurements are made from the downstream side of the single-span bridge and its approaches. The initial point for soundings is 50 feet to right of the center of the downstream tubular pier on the right bank. The channel is slightly curved for 600 feet above and 700 feet below this station. The current is sluggish at low stages, but not excessively so, and the discharge measurements are considered good at lowest stage. The right bank is high and will overflow only for 50 feet from the water's edge; the left bank will overflow for about 800 feet at a gage height of from 16 to 18 feet. The bed of the stream is sandy and probably changes.

Bench mark No. 1 is the top of the iron pier on the right bank, downstream side. Its elevation is 27.00 feet above gage datum. Bench mark No. 2 is a copper plug set in a stone post set flush with the surface of the ground at the side of the road just outside of the toll bridge, on the right bank. The post is on line with the downstream side of the bridge and is 145 feet from the center of the pier at the right-bank end of the bridge. Its elevation is 26.92 feet above gage datum.

observations at this station during 1904 have been made under ection of M. R. Hall, district hydrographer.

e measurements of Chattahoochee River near Norcross, Ga., in 1903 and 1904.

te.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
3.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
9	M. R. Hall		1,375	1.34	2.70	1,837
4	do		2,035	2.43	5.35	4,940
	do		1,854	1.91	4.08	3,543
	J. M. Giles		1,583	1.50	3.15	2,378
	do		1,570	1.56	3.13	2,447
	M. R. Hall		1,537	1.46	3.06	2,254
	do		1,537	1.46	3.06	2,255
9	do		1,503	1.55	3.15	2,337
9	do		1,486	1.54	3.05	2,288
9	F. A. Murray		1,503	1.52	3.15	2,281
9	do		1,486	1.48	3.05	2,203
er 26	do		1,245	.96	2.06	1,197
23	do		1,265	.85	1.94	1,078
er 25[a]	do		493	2.15	1.95	1,062
er 25	do		1,221	.87	1.95	1,071
4.						
19	W. E. Hall	174	1,308	1.08	2.19	1,419
19	C. A. Greene	174	1,308	1.04	2.19	1,362
20	M. R. Hall and J. C. Hoyt.	169	1,467	1.78	3.45	2,607
	W. E. Hall	173	1,314	1.14	2.50	1,496
	J. M. Giles	160	1,234	1.27	2.54	1,571
	M. R. Hall	155	1,049	.63	1.53	662
	W. E. Hall	190	2,354	4.22	8.62	9,938
	do	180	1,972	3.36	6.57	6,624
0	do	177	1,410	1.88	3.60	2,658
er 28	M. R. Hall	156	917	.59	1.22	537
er 28	do	156	919	.59	1.22	538
11	B. S. Drane	166	943	.60	1.32	569
14	M. R. Hall and N. C. Grover.	158	925	.60	1.28	558
r 9	M. R. Hall	163	1,002	.95	1.88	951

[a] Measurement taken at Warsaw Ferry, 1 mile above bridge.

Mean daily gage height, in feet, of Chattahoochee River near Norcross, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	2.20	2.50	2.55	2.30	2.40	1.70	2.65	1.80	1.35	1.25	1.[illegible]
2	1.90	2.10	2.60	2.55	2.25	2.30	1.55	2.70	1.75	1.30	1.30	1.[illegible]
3	2.00	2.10	2.60	2.50	2.20	2.30	1.50	2.35	1.70	1.35	1.35	1.[illegible]
4	1.90	2.10	2.40	2.40	2.50	2.10	1.45	2.20	1.90	1.20	1.50	1.[illegible]
5	1.90	2.10	2.30	2.35	2.40	1.95	1.70	3.10	2.40	1.15	1.65	2.[illegible]
6	1.80	2.10	2.30	2.35	2.30	1.90	1.55	2.55	2.10	1.25	1.60	2.[illegible]
7	1.80	2.30	4.70	2.50	2.20	2.65	1.50	2.15	2.05	1.30	1.50	2.[illegible]
8	2.00	3.00	6.00	3.20	3.60	2.30	1.50	7.70	1.80	1.30	1.45	2.[illegible]
9	1.90	2.90	3.90	3.40	4.05	2.05	1.30	8.20	1.70	1.30	1.40	1.[illegible]
10	1.90	2.70	3.30	3.70	3.60	1.90	1.30	3.70	1.80	1.15	1.40	1.[illegible]
11	1.90	2.70	3.00	3.00	2.80	1.80	1.55	4.50	1.65	1.25	1.40	1.[illegible]
12	2.00	2.70	2.85	2.80	2.55	1.90	1.75	3.95	1.55	1.10	1.40	1.[illegible]
13	2.00	2.50	2.70	2.70	2.40	1.80	1.85	2.85	1.60	1.30	1.60	1.[illegible]
14	2.10	2.30	3.20	2.60	2.35	1.80	1.90	2.55	1.55	1.30	1.65	1.[illegible]
15	2.10	2.30	3.10	2.50	2.35	1.70	1.60	2.40	1.50	1.20	1.60	1.[illegible]
16	2.00	2.30	2.75	2.50	2.25	1.70	1.60	2.50	1.45	1.25	1.50	1.[illegible]
17	2.20	2.20	2.60	2.55	2.20	1.70	1.85	2.15	1.45	1.25	1.50	1.[illegible]
18	2.50	2.10	2.55	2.50	2.20	1.65	1.50	2.00	1.45	1.15	1.45	1.[illegible]
19	2.20	2.30	2.50	2.45	2.15	1.20	1.65	1.90	1.40	1.10	1.45	1.[illegible]
20	2.10	3.50	2.45	2.40	2.15	1.60	1.40	2.00	1.40	1.10	1.45	1.[illegible]
21	2.00	3.60	2.60	2.40	2.10	1.50	1.70	2.20	1.40	1.10	1.40	1.[illegible]
22	2.80	4.90	3.00	2.40	2.10	1.45	1.85	1.85	1.40	1.25	1.55	1.[illegible]
23	3.10	5.30	3.40	2.40	2.05	1.35	2.05	1.70	1.40	1.25	1.80	1.[illegible]
24	3.30	4.00	3.60	2.35	2.00	1.25	1.70	1.80	1.45	1.20	1.85	1.[illegible]
25	2.60	3.30	3.50	2.30	2.00	1.20	1.60	2.05	1.40	1.20	1.65	1.[illegible]
26	2.40	2.90	3.20	2.30	2.00	1.20	1.80	2.00	1.30	1.25	1.55	1.[illegible]
27	2.30	2.80	3.00	2.45	1.95	1.40	1.80	2.40	1.20	1.30	1.50	1.[illegible]
28	2.20	2.60	2.90	2.50	1.90	1.95	1.60	2.80	1.20	1.20	1.45	1.[illegible]
29	2.20	2.60	2.75	2.35	1.90	2.30	1.70	2.45	1.25	1.10	1.45	1.[illegible]
30	2.20	.....	2.65	2.30	2.00	2.40	2.10	2.05	1.40	1.30	1.50	2.[illegible]
31	2.20	.....	2.60	.....	2.50	.....	1.90	1.90	.....	1.30	.....	2.[illegible]

Rating table for Chattahoochee River near Norcross, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.10	480	1.90	1,015	3.20	2,410	5.50	5,210
1.20	515	2.00	1,120	3.40	2,630	6.00	5,885
1.30	560	2.20	1,330	3.60	2,860	6.50	6,580
1.40	615	2.40	1,540	3.80	3,090	7.00	7,295
1.50	680	2.60	1,750	4.00	3,320	7.50	8,035
1.60	750	2.80	1,970	4.50	3,920	8.00	8,805
1.70	830	3.00	2,190	5.00	4,555	8.20	9,125
1.80	920						

The above table is based upon discharge measurements made during 1902, 1903, and 1904, and is well defined. Above gage height 1.90 feet it is the same as the 1903 curve.

Estimated monthly discharge of Chattahoochee River near Norcross, Ga., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
nuary	2,520	920	1,306
bruary	4,945	1,225	1,967
arch	5,885	1,435	2,227
pril	2,975	1,435	1,729
ay	3,380	1,015	1,510
ne	1,805	515	987
ly	1,225	560	814
ugust	9,125	830	2,079
ptember	1,540	515	764
ctober	588	480	530
ovember	968	537	689
ecember	3,090	588	1,119
The year	9,125	480	1,310

CHATTAHOOCHEE RIVER AT OAKDALE, GA.

This station was established at Oakdale, Ga., on October 17, 1895, y Cyrus C. Babb. It is located at the Southern Railway bridge, mile above the mouth of Proctor Creek, 2 miles below the mouth of eachtree Creek, one-fourth mile west of Chattahoochee, 1 mile east f Oakdale, and 8 miles northwest of Atlanta.

On July 30, 1896, the location of the station was changed to Mason nd Turner's ferry, 1 mile below Oakdale. The gage at this point, now as the "Oakdale lower gage," is nailed to a tree on the right ank 100 feet below the ferry and set 1 foot lower than the gage at the outhern Railway bridge. On June 1, 1899, the lower gage was iscontinued and the upper gage resumed and adopted by the United tates Weather Bureau, the United States Geological Survey still eceiving the records and making the current-meter discharge measurements at this point. The gage now used is in two sections, the irst, reading from zero to 8 feet, fastened to a willow tree 100 feet above the bridge on the left bank; the second, reading from 8 to 26 feet, fastened to an ash tree 30 feet above the bridge on the left bank. It is set on the same datum as the old wire gage of the United States Geological Survey established at that point by Mr. Babb in 1895 and above referred to. Its zero point is 753.5 feet above sea level. Discharge measurements are made from the railway bridge. The initial point for soundings is the end of the iron bridge on the right bank, upstream side.

Bench mark No. 1 is a railroad spike in the corner of the pier on the right bank 12.39 feet above datum of gage. Bench mark No. 2 is a large bridge spike in a sycamore tree about 50 feet above the bridge on the left bank; it is at an elevation of 11.00 feet above the zero of the gage. Bench mark No. 3, determined by measuring down to the water, is the top of the iron girder, 40 feet from the initial point for soundings, on the upstream side of the bridge. Its elevation is 57.55 feet above the zero of the gage. The flow is obstructed by rafts, which have to be cleared from the channel occasionally. The channel is straight and the current swift. The banks are subject to overflow. The bed of the stream is constant and the results are fairly good except at high stages, when the water flows through the trestlework. The observer is J. B. Austin.

This station was discontinued by the Weather Bureau on November 30, 1904, but the single daily readings for several months before that time are not considered reliable as representing the flow of the river on account of the operation of a large water-power plant above. Only the records for the first five months of the year are used.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Chattahoochee River at Oakdale, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 2	M. R. Hall	.....	2,644	3.70	9.95	9,787
March 23	J. M. Giles	.....	8,553	3.93	21.85	33,620
April 23	E. C. Murphy and M. R. Hall.	.....	1,598	3.03	5.03	4,836
June 2	J. M. Giles	.....	3,240	3.85	12.20	12,480
September 2	do	.....	809	2.00	1.25	1,612
October 7	do	.....	622	2.18	1.10	1,359
November 5	do	.....	828	2.27	1.90	1,882
1904.						
February 11	J. M. Giles	221	1,225	2.39	3.28	2,926
March 15	do	224	1,277	2.53	3.50	3,233
May 3	do	198	723	1.88	1.38	1,361
June 29	J. M. Giles and B. S. Drane.	187	556	1.85	.60	1,030

daily gage height, in feet, of Chattahoochee River at Oakdale, Ga., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
...	1.3	1.6	2.0	2.0	1.5	17	1.7	1.6	2.5	2.0	1.5
...	1.3	1.5	2.3	2.0	1.5	18	1.5	1.6	2.0	2.0	1.5
...	1.7	1.7	2.4	1.9	1.4	19	1.9	1.7	2.0	1.8	1.4
...	1.3	1.5	2.4	1.8	1.4	20	1.6	2.5	2.0	1.7	1.3
...	1.3	1.5	2.0	1.8	1.4	21	1.5	2.7	1.8	1.7	1.3
...	1.3	1.5	2.3	1.5	1.4	22	1.7	4.5	2.0	1.7	1.0
...	1.4	1.6	4.5	1.7	1.4	23	4.0	7.7	3.8	1.7	1.0
...	1.4	3.6	8.2	2.5	1.8	24	4.0	4.3	4.0	1.5	1.0
...	1.3	3.0	4.0	3.0	4.0	25	3.5	3.5	4.4	1.5	1.0
...	1.4	3.6	3.0	5.0	4.5	26	3.0	3.0	4.0	1.5	.8
...	1.4	4.0	2.8	3.0	2.7	27	3.0	2.8	3.0	1.7	.8
...	1.3	2.7	2.5	2.5	2.0	28	3.0	2.4	2.6	1.7	.8
...	1.5	2.0	2.2	2.2	1.8	29	3.5	2.0	2.3	1.5	.8
...	1.6	1.8	2.5	2.0	1.7	30	3.6	.....	2.0	1.5	1.0
...	1.5	2.0	4.5	1.9	1.7	31	1.6	.....	1.8	.....	1.7
...	1.5	1.9	3.0	1.9	1.7						

le for Chattahoochee River at Oakdale, Ga., from January 1, 1903, to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1,300	3.00	2,730	9.00	8,940	16.50	18,650
1,360	3.20	2,900	9.50	9,540	17.00	19,400
1,420	3.40	3,080	10.00	10,140	17.50	20,160
1,480	3.60	3,260	10.50	10,740	18.00	20,960
1,545	3.80	3,450	11.00	11,340	18.50	21,800
1,610	4.00	3,640	11.50	11,940	19.00	22,800
1,675	4.50	4,140	12.00	12,540	19.50	23,800
1,740	5.00	4,640	12.50	13,190	20.00	25,000
1,810	5.50	5,140	13.00	13,840	20.50	26,500
1,880	6.00	5,640	13.50	14,490	21.00	27,800
1,950	6.50	6,190	14.00	15,140	21.50	29,550
2,095	7.00	6,740	14.50	15,840	22.00	31,300
2,245	7.50	7,290	15.00	16,540	23.00	34,800
2,400	8.00	7,840	15.50	17,240	24.00	38,300
2,560	8.50	8,390	16.00	17,940		

ove table is based upon discharge measurements made during 1902–1904. defined between gage heights 0.6 feet and 12 feet. Above that point the ased upon four scattered measurements.

Estimated monthly discharge of Chattahoochee River at Oakdale, Ga., for 1904.

[Drainage area, 1,560 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,640	1,480	1,993	1.28	1.48
February	7,510	1,610	2,504	1.61	1.74
March	8,060	1,810	2,749	1.76	2.03
April	4,640	1,610	1,983	1.27	1.42
May	4,140	1,180	1,699	1.09	1.26

CHATTAHOOCHEE RIVER AT WEST POINT, GA.

This station was established July 30, 1896, by M. R. Hall, and the gage is now maintained by the United States Weather Bureau. It is located at Montgomery street wagon bridge. The boxed chain gage is securely bolted to the outside of the iron railing of the downstream footway at a point 122 to 124 feet from the initial point for soundings. The boxed gage is so constructed that the length of the chain is always 2 feet greater than the elevation of the bottom of the box above gage datum. The length of the chain is 29.26 feet from the end of the weight to the marker. The wagon bridge from which discharge measurements are made is in three spans, with short approaches from each end. The floor of the bridge is about 24 feet above low water. The initial point for soundings is the end of the hand rail on the right bank, downstream side of the bridge. The channel is straight for about 2,000 feet above and 3,000 feet below the station. The current has a fair velocity, except at low stages. The right bank is high and overflows only at high water, when most of the town is covered. The left bank is somewhat lower and overflows for about 800 feet at a gage height of 20 feet. The bed of the stream is of sand and gravel and is unstable.

Bench mark No. 1 is the top of the downstream end of the second iron floor beam under the bridge floor from the right-bank end of the highway bridge. Its elevation is 24.19 feet above gage datum. Bench mark No. 2 is the top of the thirty-eighth milepost on the Franklin and West Point survey of the United States engineers. This post is a cast-iron cap 6 inches square, set in concrete, and approximately on a level with the ground. It is marked "U. S. 38." A raised point in the center of the cap is the bench mark; its elevation is 15.68 feet above gage datum. The location of this post is on the right bank of the river, 340 feet upstream from the wagon bridge and 50 feet from the edge of the river. It is 60 feet south of the Episco-

nd is 132 feet east of the northeast corner of a lot belong-
Sheafers, which is the southwest corner of Jasper and
. Bench mark No. 3 is the top of the first marble block
of the second marble block of the Confederate monument
of the street, 1,300 feet from the initial point of sound-
feet from the east end of the bridge. Its elevation is
ove the zero of the gage.

ations at this station during 1904 have been made under
of M. R. Hall, district hydrographer.

urements of Chattahoochee River at Westpoint, Ga., in 1903 and 1904.

Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
	Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
M. R. Hall	383	3,550	1.42	3.95	5,056
E. C. Murphy & M. R. Hall.	394	4,040	2.16	5.39	8,713
M. R. Hall	381	5,458	3.84	9.70	20,960
do	386	6,046	4.24	11.30	25,620
J. M. Giles	358	3,312	1.44	3.46	4,761
do	356	3,569	1.68	4.07	5,993
M. R. Hall	375	2,875	.85	2.40	2,451
do	369	2,858	.85	2.32	2,416
W. E. Hall	376	2,901	.85	2.37	2,460
W. E. Hall	376	3,101	.97	2.80	3,005
J. M. Giles	377	2,781	1.13	2.83	3,144
do	377	2,787	1.13	2.88	3,155
do	377	2,805	1.13	2.90	3,179
do	377	2,785	1.14	2.90	3,180
do	353	2,223	.58	1.56	1,298
do	353	2,228	.59	1.56	1,306
W. E. Hall	368	2,397	.50	1.46	1,203
do	371	2,621	.71	2.00	1,862
J. M. Giles	368	2,451	.41	1.20	1,005
do	368	2,474	.41	1.27	1,010
W. E. Hall	380	2,933	.96	2.70	2,808

Mean daily gage height, in feet, of Chattahoochee River at Westpoint, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.4	2.9	3.3	2.9	2.5	3.0	2.5	2.6	2.3	1.2	1.2	1.7
2	2.3	2.9	3.3	2.9	2.5	3.6	2.3	2.7	1.4	1.2	.9	1.8
3	2.4	2.9	3.7	2.9	2.4	2.7	2.1	2.5	2.0	1.2	1.1	1.9
4	2.4	2.8	3.5	2.8	2.4	2.4	2.1	3.3	1.9	1.2	1.5	2.0
5	2.4	2.8	3.3	2.7	2.4	2.2	1.7	2.5	1.8	1.1	1.7	2.0
6	2.3	2.8	3.1	2.7	2.4	2.1	1.9	3.1	2.5	1.1	1.6	2.6
7	2.3	3.1	4.7	2.8	2.4	1.5	1.6	5.3	2.4	1.2	1.6	3.0
8	2.4	4.8	6.0	3.2	2.4	1.4	1.3	11.4	2.2	1.2	1.5	3.2
9	2.4	5.0	6.0	3.6	2.4	2.0	2.4	12.6	2.1	1.1	1.6	3.1
10	2.7	4.4	5.4	3.5	3.1	2.3	2.1	12.4	1.9	1.1	1.5	2.5
11	3.0	5.4	4.2	3.5	3.4	2.1	1.8	9.6	1.7	1.1	1.5	2.2
12	2.8	5.1	3.7	3.4	3.1	2.0	1.6	6.2	1.6	1.1	1.5	2.1
13	2.7	4.1	3.6	3.1	2.6	1.8	1.6	4.8	1.6	1.2	1.6	1.9
14	2.7	3.7	3.6	2.9	2.4	1.6	1.8	4.2	1.6	1.1	1.7	2.0
15	2.7	3.4	4.0	2.8	2.3	1.6	1.9	5.0	1.5	1.0	1.8	1.8
16	2.6	3.3	4.2	2.7	2.3	1.6	1.4	4.0	1.5	1.0	1.7	1.8
17	3.5	3.2	3.7	2.7	2.3	1.6	1.4	3.9	1.4	1.0	1.6	1.8
18	3.6	3.0	3.4	2.7	2.3	1.5	1.7	3.4	1.4	1.1	1.6	1.8
19	3.3	3.1	3.2	2.7	2.2	1.5	1.4	3.0	1.4	1.0	1.6	1.8
20	3.1	3.7	3.1	2.7	2.1	1.5	2.0	2.9	1.3	1.1	1.6	1.8
21	2.8	4.0	3.0	2.7	2.0	1.5	1.7	2.3	1.3	1.2	1.6	1.7
22	3.3	5.4	3.0	2.7	2.0	1.4	2.0	2.4	1.4	.9	1.6	1.7
23	5.5	6.4	3.3	2.7	2.0	1.3	2.1	2.2	1.8	.9	1.8	1.7
24	5.1	6.1	3.3	2.6	1.9	1.7	2.3	2.2	1.9	.9	1.8	1.7
25	4.2	5.3	3.8	2.6	1.9	1.3	2.0	4.3	1.5	.9	1.8	1.9
26	3.8	4.3	3.8	2.6	1.9	1.4	1.9	5.1	1.4	.9	1.8	2.1
27	3.3	3.9	3.6	2.6	1.8	1.3	1.4	4.1	1.3	1.1	1.7	2.1
28	3.0	3.6	3.3	2.6	1.8	1.2	1.9	5.8	1.3	1.2	1.7	3.5
29	3.0	3.4	3.2	2.6	1.8	1.4	1.7	3.9	1.3	1.1	1.7	3.6
30	2.9	.....	3.1	2.6	1.8	2.0	2.1	3.0	1.3	1.0	1.6	3.7
31	2.9	.....	3.0	.....	2.7	.....	2.2	2.4	.....	1.1	.....	3.6

Rating table for Chattahoochee River at Westpoint, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.90	800	2.00	1,840	4.20	5,830	6.40	11,380
1.00	850	2.20	2,100	4.40	6,290	6.60	11,940
1.10	920	2.40	2,380	4.60	6,760	6.80	12,520
1.20	1,000	2.60	2,680	4.80	7,240	7.00	13,100
1.30	1,090	2.80	3,000	5.00	7,740	8.00	16,000
1.40	1,180	3.00	3,340	5.20	8,240	9.00	18,900
1.50	1,280	3.20	3,700	5.40	8,740	10.00	21,800
1.60	1,380	3.40	4,080	5.60	9,260	11.00	24,700
1.70	1,490	3.60	4,500	5.80	9,780		
1.80	1,600	3.80	4,940	6.00	10,300		
1.90	1,720	4.00	5,380	6.20	10,840		

The foregoing table is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.20 feet and 11.40 feet. The table has been extended beyond these limits. Above gage height 6.50 feet the rating curve is a tangent, the difference being 290 per tenth.

Estimated monthly discharge of Chattahoochee River at Westpoint, Ga., for 1904.

[Drainage area, 3,300 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	9,000	2,240	3,520	1.07	1.23
February	11,380	3,000	5,447	1.65	1.78
March	10,300	3,340	4,858	1.47	1.70
April	4,500	2,680	3,107	.942	1.05
May	4,080	1,600	2,285	.692	.798
June	4,500	1,000	1,695	.514	.574
July	2,530	1,090	1,705	.517	.596
August	29,340	2,100	7,515	2.28	2.63
September	2,530	1,090	1,484	.450	.502
October	1,000	800	913	.277	.319
November	1,600	800	1,375	.417	.465
December	4,720	1,490	2,294	.695	.801
The year	29,340	800	3,016	.914	12.44

SOQUE RIVER NEAR DEMOREST, GA.

This station was established July 16, 1904, by M. R. Hall. It is located at Cannon Bridge on road from Cornelia to Acorn, 2½ miles from Demorest and about 4 miles above the mouth of the river. The gage is a vertical 10-foot timber fastened to a scantling which is spiked to the sill and upstream post of trestle bent at the left bank. It is graduated to feet and tenths. The gage is read once each day by Charles Cannon. This station is maintained in cooperation with the Georgia Geological Survey, by whom the gage reader is paid. Discharge measurements are made from the single-span, wooden, wagon bridge, to which the gage is attached. The bridge has a 28-foot approach on the left bank and 90-foot approach on the right bank. The initial point for soundings is the end of the bridge on the upstream side at the left bank. The channel is curved for 500 feet above and slightly curved for 500 feet below the station. The current is swift. Both banks are high and wooded. The right bank overflows during extreme high water. The bed of the stream is composed largely of rock and is permanent. There is but one channel at all stages. *Bench mark* No. 1 is the top of the upstream end

of the right bank wooden pier, and is marked with white paint. Its elevation is 21.30 feet above the zero of the gage. Bench mark No. 2 is a nail in an ironwood tree 20 feet above bridge on the right bank. Its elevation is 6.00 feet above the zero of the gage.

Discharge measurements of Soque River near Demorest, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
June 8	J. M. Giles	74	159	1.14	1.74	182
July 16	M. R. Hall	74	139	.88	1.46	123
August 24	W. E. Hall	81	209	.97	1.81	202
October 28	M. R. Hall	81	169	.60	1.31	102
October 28	do	81	169	.60	1.31	101
November 23	W. E. Hall	80	192	.78	1.58	150

Mean daily gage height, in feet, of Soque River near Demorest, Ga., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.25	1.65	1.40	1.35	1.40	17	1.40	1.80	1.50	1.30	1.40	1.50
2	.....	2.10	1.65	1.35	1.40	1.40	18	1.35	1.80	1.45	1.30	1.40	1.50
3	.....	2.15	1.60	1.35	1.40	1.45	19	1.40	1.75	1.50	1.30	1.40	1.55
4	.....	1.70	2.75	1.35	1.65	1.55	20	1.40	2.20	1.45	1.30	1.40	1.50
5	.....	2.00	2.60	1.35	1.60	3.05	21	1.40	1.75	1.60	1.25	1.40	1.50
6	.....	3.45	2.00	1.35	50	2.30	22	3.70	1.70	1.50	1.25	1.45	1.45
7	.....	1.60	1.85	1.40	1.40	1.70	23	1.55	1.60	1.40	1.30	1.60	1.45
8	.....	5.25	2.10	1.40	40	1.65	24	1.50	1.65	1.40	1.30	1.65	1.45
9	.....	2.90	1.85	1.35	1.35	1.55	25	2.30	2.30	1.45	1.30	1.50	1.70
10	.....	2.70	1.70	1.40	1.35	1.50	26	1.60	2.35	1.45	1.30	1.45	1.65
11	.....	1.95	1.60	1.35	1.35	1.45	27	1.45	2.40	1.50	1.30	1.40	2.40
12	.....	2.40	1.60	1.35	1.40	1.45	28	1.40	2.10	1.45	1.30	1.40	2.30
13	.....	2.00	1.60	1.35	1.45	1.55	29	1.65	2.00	1.40	1.30	1.40	2.10
14	.....	95	1.55	1.35	1.45	1.50	30	1.50	1.75	1.40	1.30	1.40	1.85
15	.....	1.80	1.50	1.30	1.40	1.50	31	2.70	1.70	.....	1.35	.....	1.70
16	1.45	85	1.50	1.30	1.40	1.50							

Rating table for Soque River near Demorest, Ga., from July 16 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.25	93	1.50	132	1.80	198	2.10	282
1.30	100	1.60	152	1.90	224	2.20	314
1.40	115	1.70	174	2.00	252		

The above table is based upon six discharge measurements made during 1904 and one measurement made in 1905. It is well defined between gage heights 1.30 feet and 2.20 feet. Estimates made above 2.50 feet can only be considered a rough approximation.

Estimated monthly discharge of Soque River near Demorest, Ga., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
July (16–31)	980	108	218
August	1,745	93	322
September	525	115	174
October	115	93	104
November	163	108	122
December	666	115	183

SWEETWATER CREEK NEAR AUSTELL, GA.

This station was established May 6, 1904, by M. R. Hall. It is located at the south side of Lithia Springs Park, near Austell, Ga. The station is maintained in cooperation with the Georgia Geological Survey, by whom the gage reader is paid. The gage is composed of two sections. The first or inclined section, graduated by tenths to 8 feet, is bolted to a large rock on the right bank. The second or vertical section, graduated from 8 to 16 feet, is spiked to a maple tree on the right bank about 100 feet upstream. The gage is read twice each day by J. L. Causey. Discharge measurements are made from a boat at low and ordinary stages about 400 yards below the gage. High-water measurements are made from Strickland's wagon bridge, 1½ miles downstream. The channel is straight for about 300 feet above and for 200 feet below the gage. The current above the gage is sluggish; below the gage it is swift for about 50 feet, at several places with sluggish water between. Both banks are high and wooded, the right being composed of rock, and are not liable to overflow. There is but one channel at all stages. Bench mark No. 1 is a nail in a small maple on the right bank about 200 feet below the gage. Its elevation is 5.00 feet above the zero of the gage. Bench mark No. 2 is a cross cut on a large rock about 10 feet south of the sloping section of the gage. Its elevation is 10.00 feet about the zero of the gage.

Discharge measurements of Sweetwater Creek near Austell, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 6 [a]	W. E. and M. R. Hall.	42	148	0.82	1.68	122
June 16 [b]	J. M. Giles	45	71	.85	1.15	61
June 16 [a]	do	41	119	.54	1.20	64
July 9 [a]	W. E. Hall	43	140	.61	1.40	85
July 29 [a]	J. M. Giles	54	201	1.26	2.70	254
August 30 [a]	W. E. Hall	53	194	.92	2.35	178
August 31 [c]	J. M. Giles	45	99	1.24	1.96	122
October 1 [d]	M. R. Hall	55	105	.58	1.24	61
October 1 [d]	do	55	104	.58	1.28	60

[a] Strickland's bridge.
[b] Boat 100 yards below gage.
[c] Wading 100 yards below gage.
[d] 1,000 feet above gage.

Mean daily gage height, in feet, of Sweetwater Creek near Austell, Ga., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.40	1.90	1.50	1.90	0.90	0.90	1.65
2	.....	2.50	1.45	1.60	1.70	.65	1.05	1.60
3	.....	1.90	1.30	4.40	1.60	1.05	.95	1.80
4	.....	1.60	1.25	2.90	3.00	.70	1.60	1.85
5	.....	1.50	1.20	3.90	2.65	1.05	1.80	2.50
6	.....	1.50	1.10	3.85	2.05	.75	1.70	3.65
7	.....	1.95	1.05	2.30	1.70	.95	1.40	2.60
8	.....	1.70	1.35	11.90	1.65	.90	1.35	2.25
9	.....	1.45	1.35	16.30	1.60	.65	1.25	2.05
10	.....	1.30	1.15	11.40	1.45	.90	1.25	2.05
11	.....	1.20	1.10	4.95	1.40	.90	1.25	2.20
12	.....	1.20	1.05	6.30	1.30	.85	1.30	2.00
13	.....	1.10	1.15	4.30	1.25	.90	1.65	1.85
14	.....	1.00	.90	3.45	1.25	.95	2.10	1.75
15	.....	1.00	1.00	3.25	1.35	.85	1.75	1.75
16	.....	1.15	1.05	4.55	1.10	.55	1.45	1.80
17	.....	1.00	.55	3.20	.90	1.00	1.40	1.85
18	1.50	1.00	1.00	3.45	1.20	.70	1.35	1.75
19	1.50	1.00	.75	2.40	1.20	.70	1.45	1.80
20	1.45	1.90	.75	1.95	1.05	.85	1.40	1.65
21	1.45	2.80	.75	2.15	1.10	.70	1.45	1.65
22	1.35	3.50	.90	2.00	1.10	.75	1.80	1.60
23	1.30	2.15	1.15	1.95	1.00	.60	2.40	1.70
24	1.30	1.70	.70	2.65	1.15	1.00	2.00	1.65
25	1.25	1.30	1.05	4.05	1.00	.90	1.75	1.65
26	1.15	1.15	1.00	5.50	1.05	.90	1.60	1.65
27	1.20	1.20	.90	7.15	.85	.85	1.45	1.75
28	1.20	2.40	1.25	6.00	1.10	.85	1.60	3.45
29	1.15	5.60	2.50	3.10	1.05	.90	1.50	3.25
30	1.30	2.85	2.20	2.35	.95	.50	1.50	3.20
31	2.55	.....	1.65	2.10	.....	.95	.....	2.50

MULBERRY CREEK NEAR COLUMBUS, GA.

This station was established as a bench-mark station June 23, 1904, y W. E. Hall. It is located at Mitchell's bridge, about 16 miles orth of Columbus, Ga., and 12 miles south of Hamilton, Ga. Mulerry Creek is a tributary of Chattahoochee River, which it enters bout 6 miles to the west of the station. Discharge measurements are ade from the downstream side of the two-span open wooden truss ighway bridge, resting upon stone abutments and center wooden pile ent. The initial point for soundings is the left end of the bridge on e downstream side. The channel is straight for about 50 feet above nd 200 feet below the bridge. The current is rather sluggish above nd swift below the station. Both banks are high and not liable to verflow. The right bank is clean; the left bank is wooded and covred with brush. The bed of the stream is composed of rock and and. There is but one channel at all stages, broken by one wooden ier. The bottom is very uneven, causing the currents to change irections during low water. The bench mark is the top of the downtream end of the wooden cap of center pile bent. Its elevation is 2.00 feet above datum.

Discharge measurements of Mulberry Creek near Columbus, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
ne 23	W. E. Hall	38	62	0.92	1.40	58
ptember 21	do	32	47	.68	1.23	32
ptember 21	do	32	47	.70	1.23	33

FLINT RIVER NEAR WOODBURY, GA.

Measurements of the flow of Flint River were made during 1897 and 98 at Molina, Ga., but the river bed was so shifting that the station as discontinued on June 2, 1898. Two measurements were made in 99 at the Macon and Birmingham Railroad bridge, near Woodbury, a., 5 miles below the Molena station. On March 29, 1900, a gage as put in near this bridge, and the station was reestablished.

The gage is graduated on a 1 by 5 inch plank in 5-foot sections; the art reading from zero to 10 feet is attached to a willow tree on the ft bank about 300 feet above the bridge and about 50 feet below iggins's old ferry; the section reading from 10 to 15 feet is fastened a sweet gum tree 50 feet from the left bank and 150 feet upstream om the bridge. This gage was maintained by the Georgia Geological urvey until November 1, 1900, when it was adopted by the United tates Weather Bureau instead of the one at Reynolds, Ga. The

observer is G. A. Wright, who is paid by the United States Weather Bureau. Discharge measurements are made from the Macon and Birmingham Railroad bridge and its trestle approaches. This is a two-span iron bridge, each span being 150 feet long and supported by brick piers. There are wooden trestle approaches about 150 feet on the right bank and 225 feet on the left. The initial point for soundings is the end of the iron bridge on the right bank, downstream side. The bridge and its piers are oblique to the direction of the current, and the bed is rough and irregular and mostly permanent. The channel above and below the station is slightly curved for 800 feet. Above ten feet the banks are subject to overflow for a width of 300 or 400 feet, but all water passes beneath the bridge and its approaches.

Bench mark No. 1 is the top of the downstream end of the second and third crossbeams from the left bank end of the bridge. The elevation of this bench mark is 27.00 feet above the zero of the gage. Bench mark No. 2 is a cut in the hickory tree on the upstream side of the old ferry landing, 50 feet from the left bank of the river and about 75 feet upstream from the gage. Its elevation is 7.00 feet above the zero of the gage. Bench mark No. 3 is a copper plug set in solid rock on the west side of the river about 100 feet from the water and 100 feet upstream from a point opposite the gage. Its elevation is 16.24 feet above the zero of the gage. The zero of the gage is at an elevation of 660 feet above sea level.

The observations at the station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Flint River near Woodbury, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
April 22	E. C. Murphy		1,145	2.34	2.45	2,679
February 12[a]	M. R. Hall		2,974	5.48	9.20	16,290
March 26	J. M. Giles		2,104	4.21	5.45	8,861
June 29	do		1,042	1.53	1.48	1,591
July 30	do		704	.71	.37	503
September 30	M. R. Hall		690	.56	.28	387
1904.						
February 11	F. A. Murray	255	1,350	2.29	2.81	3,095
February 23	W. E. Hall	247	1,478	2.78	3.30	4,114
March 30	J. M. Giles	218	757	.82	.74	620
July 7	W. E. Hall	238	694	.37	.00	256
August 25	B. S. Drane	291	745	.51	.30	383
October 4[b]	J. M. Giles	208	345	.51	.25	178

[a] This is a flood measurement. Stage being high for this station. Results considered fairly accurate.
[b] *Taken from boat one-half mile above bridge.*

Mean daily gage height, in feet, of Flint River near Woodbury, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	0.50	0.90	1.20	0.70	0.40	1.10	0.30	0.40	0.20	-.25	-0.35	0.10
.....	.50	.90	1.30	.60	.40	1.00	.20	1.30	.10	-.30	-.30	.20
.....	.60	.80	1.50	.70	.50	.80	.10	1.10	.10	-.30	-.20	.30
.....	.70	.70	1.60	.60	.60	.50	.10	1.20	.50	-.30	.00	.40
.....	.60	.80	2.00	.60	.50	.30	.00	2.20	.80	-.30	.00	.50
.....	.50	.70	2.50	.70	.50	1.00	.00	2.10	.70	-.35	.10	.90
.....	.60	.80	2.30	.80	.40	.80	.00	2.20	.30	-.35	.00	.90
.....	.70	2.60	2.20	.90	.30	.60	-.05	8.70	.20	-.40	.00	.70
.....	.60	2.50	2.10	1.90	.20	.50	.10	6.50	.20	-.40	-.10	.50
.....	.80	2.30	1.90	1.40	.30	.40	.10	5.00	.10	-.40	-.05	.50
.....	1.20	2.80	1.50	1.00	.30	.40	.60	5.00	.00	-.35	-.05	.40
.....	1.00	2.50	1.30	.80	.30	.00	.30	3.50	.00	-.35	-.05	.30
.....	.90	2.20	1.10	.70	.20	.00	.20	3.00	.00	-.40	.10	.30
.....	.80	2.00	1.20	.60	.10	.00	.20	1.20	-.05	-.40	.20	.30
.....	.70	1.70	1.40	.60	.20	-.05a	.00	1.50	-.10	-.40	.20	.30
.....	.80	1.40	1.20	.60	.20	-.05	-.05	1.40	-.10	-.40	.10	.30
.....	1.30	1.20	1.00	.50	.10	-.05	-.10	.90	-.10	-.45	.10	.30
.....	1.50	1.10	1.00	.50	.20	-.05	-.10	.50	-.10	-.45	.10	.20
.....	1.40	1.20	.90	.40	.10	-.05	.10	.50	-.15	-.40	.10	.20
.....	1.20	1.40	.90	.50	.10	-.05	.10	.40	-.20	-.40	.00	.20
.....	1.00	1.50	.80	.40	.10	-.05	-.05	.30	-.15	-.45	.00	.20
.....	1.10	2.60	.90	.40	.00	-.05	.20	.30	-.15	-.45	.10	.30
.....	3.20	3.00	.90	.50	.00	-.05	.10	.30	-.20	-.45	.10	.20
.....	3.60	2.90	.90	.40	.00	-.05	.80	.40	-.25	-.50	.20	.20
.....	2.70	2.50	.80	.50	.00	-.05	1.00	.30	-.15	-.45	.20	.40
.....	1.90	2.00	.90	.40	.00	.00	.40	.70	-.30	-.40	.10	.50
.....	1.50	1.90	.90	.50	.00	.00	.20	.10	-.20	.35	.10	.60
.....	1.20	1.40	.80	.40	.00	.00	.10	.30	-.20	-.40	.10	1.30
.....	1.10	1.20	.90	.40	.00	.40	.00	.60	-.25	-.35	.10	1.50
.....	1.00	.....	.80	.50	.00	.40	.10	.50	-.25	-.35	.10	1.30
.....	.90	.....	.80	.....	1.00	.....	.20	.30	.....	-.40	.....	1.10

June 15 to 25 observer reported "below zero" but stated afterward that he did not think it went much as 1 tenth below.

Rating table for Flint River near Woodbury, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.50	120	1.00	1,005	3.00	3,410	5.00	6,520
−.45	135	1.10	1,115	3.10	3,545	5.20	6,880
−.40	150	1.20	1,225	3.20	3,680	5.40	7,260
−.35	165	1.30	1,340	3.30	3,820	5.60	7,640
−.30	180	1.40	1,455	3.40	3,960	5.80	8,040
−.25	195	1.50	1,570	3.50	4,100	6.00	8,450
−.20	210	1.60	1,685	3.60	4,240	6.20	8,880
−.15	225	1.70	1,800	3.70	4,390	6.40	9,320
−.10	240	1.80	1,920	3.80	4,540	6.60	9,780
−.05	260	1.90	2,040	3.90	4,690	6.80	10,260
.00	280	2.00	2,160	4.00	4,840	7.00	10,750
.10	320	2.10	2,280	4.10	5,000	7.20	11,250
.20	360	2.20	2,400	4.20	5,160	7.40	11,750
.30	410	2.30	2,520	4.30	5,320	7.60	12,250
.40	470	2.40	2,640	4.40	5,480	7.80	12,750
.50	540	2.50	2,760	4.50	5,650	8.00	13,250
.60	620	2.60	2,890	4.60	5,820	8.50	14,500
.70	705	2.70	3,020	4.70	5,990	9.00	15,750
.80	800	2.80	3,150	4.80	6,160	9.50	17,000
.90	900	2.90	3,280	4.90	6,340	10.00	18,250

The above table is well defined between −0.2 feet and 4.5 feet. Above this point the table is based on one measurement at 9.2 feet. It is based upon discharge measurements made during 1901–1904.

Estimated monthly discharge of Flint River near Woodbury, Ga., for 1904.

[Drainage area, 988 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
nuary	3,680	540	1,207	1.22	1.41
ebruary	3,410	705	1,838	1.86	2.01
arch	2,760	800	1,326	1.34	1.55
pril	2,040	470	687	.695	.775
ay	1,005	280	394	.399	.460
ne	1,115	260	442	.447	.499
ly	1,005	240	368	.372	.429
gust	15,000	320	2,198	2.22	2.56
ptember	800	180	302	.306	.341
tober	195	120	155	.157	.181
vember	360	165	295	.299	.334
ecember	1,570	320	586	.593	.684
The year	15,000	120	816	.826	11.23

FLINT RIVER AT ALBANY, GA.

This station was originally established by the United States Weather ureau on April 10, 1893, and has been maintained from that date to e present. The gage was washed out and replaced in 1898. It was ain injured in 1902, and was replaced by a new gage on June 17, 02, which was read for the first time on June 18. The new gage as set seventy-five hundredths of a foot lower than the old gage. he gage as it existed prior to June 17, 1902, is described in Water-pply Paper No. 48, page 156. R. V. Watson was employed by the eather Bureau to make and set the new gage, and it appears from r. Watson's description of this gage on June 17, 1902, that a cer-in bench mark cut in the lower iron pier of the county bridge and scribed in Paper No. 48, above referred to, as being 10 feet above ro of gage, was in reality only 9 feet and 3 inches above the zero of e old gage. As Mr. Watson set the new gage 10 feet below this nch mark, its zero is 9 inches lower than that of the old gage. The age heights have been corrected from January 1 to June 17, 1902, clusive, to correspond with the new gage, so that one rating table ill apply to the whole year.

The following is Mr. Watson's description of the United States Weather Bureau gage: The name of the bridge to which the gage is ttached is the Dougherty County Flint River Bridge, located at

Albany, Ga., about 700 feet below the Atlantic Coast Line Railway bridge. The gage is in three parts or sections. No. 1 is attached to the crib around the middle piers (the crib is filled with rocks, being 30 by 14 feet), and extends about 3 feet above ordinary low water. This section reads to 4 feet above zero. It is securely spiked to the wooden crib. Section No. 2 is securely spiked to a green cypress tree just above the bridge on the west bank of the river, and reads from 2 to 17 feet above the zero on No. 1. No. 3 is securely spiked to a cedar post 16 feet high, the post being put 3 feet into the firm ground. This section begins at 17 feet above the zero on No. 1 and reads to 32 feet, which is about 2½ feet above any high water known since 1840.

A 24-inch iron top locked box chain gage belonging to the United States Geological Survey was put in by W. E. Hall on April 20, 1904. The box is securely bolted to the iron lattice of the hand railing of the downstream footway of the Dougherty County Bridge, near the middle part of the west span of the bridge. The graduated scale is 24 feet long, and is bolted to the same latticework, the zero end being in contact with the end of the box, and the scale extending west toward the right bank. This gage was accurately set to correspond with the bench marks previously established, and its readings agree with the standard portion of the Weather Bureau gage. The bottom of the box is 45.34 feet above the zero of the gage, and the length of the chain from the bottom of the weight to the marker is 47.34 feet.

Discharge measurements by the Geological Survey were begun at this station in 1901, and the gage height records furnished by the Weather Bureau have been used, except for a portion of the year 1903. The present observer, D. W. Brosnan, is now paid by the United States Weather Bureau.

Discharge measurements are made from the two-span railroad bridge of the Atlantic Coast Line, which is 325 feet long, with 475 feet of trestle approach on the right bank and 240 feet on the left bank.

The initial point for soundings is the center of the tubular iron pier on the upstream side of the bridge on the left bank. The channel above the station is straight for about 1,000 feet and is rough. Below the station the channel is straight for 700 feet. The river overflows both banks, but only under the approaches to the bridge. The bed is constant, but is rough, and the current is irregular.

Bench mark No. 1 is a copper plug set in the downstream corner of the brick abutment on the right bank, under the Dougherty County Bridge. Its elevation is 33.81 feet above the zero of the gage. Bench mark No. 2 is the top of the first crossbeam from the right bank, upstream end of the railroad bridge. Its elevation is 43.20 feet above the zero of the gage. Bench mark No. 3 is a chisel mark on the tubular pier of the wagon bridge on the right bank, downstream side.

ation is 10.00 feet above the zero of the gage. Bench mark the top of the third granite block of the Confederate monument enter of Jackson and Pine streets. This is at the bottom of the l block which bears the inscription. Its elevation is 61.09 feet e zero of the gage.

bservations at this station during 1904 have been made under ction of M. R. Hall, district hydrographer.

scharge measurements of Flint River at Albany, Ga., in 1903 and 1904.

	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
3.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
.....	F. A. Murray	.....	4,249	4.38	13.68	18,630
.....	M. R. Hall	.....	5,352	4.32	16.80	23,120
.....	F. A. Murray	.....	2,283	3.38	5.65	7,744
r 18 ..	M. R. Hall	.....	4,124	4.03	13.06	16,640
4.....	.....do	.....	1,488	2.34	1.90	3,484
r 22...	F. A. Murray	.....	1,757	2.92	3.25	5,035
4.						
.....	W. E. Hall	227	1,677	2.67	2.78	4,474
.....	B. S. Drane	264	1,373	1.54	.25	2,111
r 22 ..	J. M. Giles	221	1,342	1.52	.20	2,044
r 23 ..	.....do	221	1,351	1.56	.20	2,104
r 15 ..	B. S. Drane	271	1,455	2.08	1.11	3,030
r 16 ..	.....do	271	1,428	2.14	1.20	3,056
r 21 ..	.....do	269	1,384	1.86	.63	2,423
r 21 ..	.....do	269	1,353	1.88	.61	2,378

Mean daily gage height, in feet, of Flint River at Albany, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.2	6.3	8.2	4.2	2.0	0.9	0.5	1.1	5.3	−0.1	−0.3	0.5
2	4.4	5.9	7.3	3.9	2.0	1.5	1.5	1.6	3.1	− .1	− .3	.6
3	4.2	5.6	6.7	3.7	1.9	2.6	1.5	1.6	2.2	− .1	− .2	.7
4	4.2	5.2	6.4	3.6	1.9	2.7	1.1	2.9	1.8	− .2	.1	1.6
5	4.1	5.0	6.3	3.4	2.4	2.4	.8	5.5	1.6	− .3	.5	2.8
6	4.0	4.7	6.6	3.2	2.5	1.9	.6	5.9	1.5	− .3	.8	3.6
7	3.9	4.8	7.0	3.3	2.2	1.5	.5	5.6	1.7	− .3	.9	3.6
8	4.4	5.2	7.3	4.1	1.9	1.3	.5	6.4	2.3	− .3	.8	3.5
9	4.7	6.4	7.3	5.0	1.7	1.1	.4	7.2	2.3	− .2	.6	3.4
10	5.1	8.8	7.8	5.4	1.6	1.3	.4	7.8	1.9	− .2	.4	3.1
11	6.0	12.9	8.1	5.9	1.6	1.2	.4	8.3	1.5	− .2	.3	2.6
12	6.4	16.9	8.1	5.9	1.6	1.0	.7	9.4	1.1	− .3	.3	2.4
13	7.0	19.2	7.5	5.4	1.5	.8	.9	10.8	1.0	− .3	.4	2.0
14	7.0	18.7	6.8	4.7	1.3	.7	1.1	12.2	.7	− .3	.7	1.8
15	6.8	17.2	6.4	3.8	1.3	.6	1.4	13.1	.6	− .3	1.1	1.6
16	6.4	15.8	6.2	3.4	1.3	.5	1.0	13.2	.6	− .3	1.2	1.5
17	6.0	14.8	6.2	3.2	1.4	.4	.7	12.1	.5	− .3	1.1	1.4
18	5.9	13.3	6.1	3.0	1.5	.3	.5	8.0	.4	− .4	.9	1.4
19	5.8	10.5	5.8	2.7	1.9	.2	.4	4.9	.4	− .4	.8	1.5
20	6.0	8.5	5.2	2.5	1.9	.2	.2	4.7	.3	− .4	.7	1.6
21	6.0	8.4	5.0	2.4	1.7	.2	.2	2.9	.2	− .4	.7	1.6
22	5.8	9.3	4.8	2.4	1.4	.1	.2	2.5	.2	− .4	.6	1.4
23	6.8	10.5	4.5	2.4	1.1	.3	.4	2.1	.2	− .4	.7	1.3
24	8.1	10.9	4.2	2.3	1.0	.5	.9	2.0	.2	− .4	.9	1.2
25	9.5	10.9	4.2	2.3	.8	.5	1.4	2.0	.1	− .4	1.1	1.2
26	9.7	10.6	4.1	2.2	.8	.4	1.2	2.2	.1	− .5	1.1	1.2
27	10.0	10.4	4.5	2.2	.7	.4	1.0	2.8	.1	− .5	1.0	1.2
28	10.4	10.1	5.0	2.1	.6	.3	1.2	4.0	.0	− .5	.9	1.6
29	10.3	9.4	4.9	2.0	.5	.3	1.0	4.1	.0	− .4	.7	2.3
30	9.0	.....	4.8	2.0	.6	.3	.7	6.0	.0	− .4	.6	3.2
31	7.0	.....	4.3	.....	.9	.....	1.0	6.4	.....	− .3	.....	4.1

Rating table for Flint River at Albany, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
—0.50	1,480	1.00	2,780	5.50	7,425	13.00	16,750
— .40	1,560	1.20	2,960	6.00	8,000	13.50	17,525
— .30	1,645	1.40	3,140	6.50	8,575	14.00	18,300
— .20	1,730	1.60	3,330	7.00	9,150	14.50	19,150
— .10	1,815	1.80	3,520	7.50	9,725	15.00	20,000
.00	1,900	2.00	3,710	8.00	10,300	15.50	20,850
.10	1,985	2.20	3,900	8.50	10,900	16.00	21,700
.20	2,070	2.40	4,100	9.00	11,500	16.50	22,550
.30	2,155	2.60	4,300	9.50	12,100	17.00	23,400
.40	2,240	2.80	4,500	10.00	12,700	17.50	24,300
.50	2,330	3.00	4,700	10.50	13,350	18.00	25,200
.60	2,420	3.50	5,225	11.00	14,000	18.50	26,100
.70	2,510	4.00	5,750	11.50	14,675	19.00	27,000
.80	2,600	4.50	6,300	12.00	15,350	19.50	27,950
.90	2,690	5.00	6,850	12.50	16,050	20.00	28,900

The above table is based upon eighteen discharge measurements made during 1902–1904. It is well defined between gage heights 0.0 foot and 6 feet. Above 6 feet the table is approximate.

Estimated monthly discharge of Flint River at Albany, Ga., for 1904.

[Drainage area, 5,000 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
nuary	13,220	5,645	8,553	1.71	1.97
bruary	27,380	6,520	13,550	2.71	2.92
arch	10,540	5,860	8,068	1.61	1.86
pril	7,885	3,710	5,175	1.04	1.16
ay	4,200	2,330	3,215	.643	.741
ne	4,400	1,985	2,683	.537	.599
ly	3,235	2,070	2,587	.517	.596
ugust	17,060	2,870	7,949	1.59	1.83
eptember	7,195	1,900	2,872	.574	.640
ctober	1,815	1,480	1,629	.326	.376
ovember	2,960	1,645	2,457	.491	.548
ecember	5,860	2,330	3,723	.745	.859
The year	27,380	1,480	5,205	1.04	14.10

BIG POTATO CREEK NEAR THOMASTON, GA.

This station was established as a bench-mark station. It is located at the highway bridge, about 5 miles southwest of Thomaston, Ga., 200 yards above Daniel's old gristmill. Discharge measurements are made from the downstream side of the single-span iron bridge, which has trestle approaches of about 100 feet at each end. The initial point for soundings is the left end of the bridge on the downstream side. The channel is curved for about 200 feet above and straight for 300 feet below the station. The current is swift, except at very low stages. Both banks are subject to occasional overflow. The bed of the stream is composed of rock and gravel, free from vegetation, and probably constant. There is but one channel at all stages, broken during the higher water by the piers of the bridge. Bench mark No. 1 is the top of the downstream end of the first floor beam from the left bank. Its elevation is 23.00 feet above datum. Bench mark No. 2 is a chisel mark on the intermediate post at the downstream end of the second floor beam. Its elevation is 28.00 feet above datum.

Discharge measurements of Big Potato Creek near Thomaston, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 31	J. M. Giles	87	212	0.77	2.32	164
May 24	M. R. Hall	85	165	.36	1.75	60
July 6	W. E. Hall	80	132	.46	1.80	61
September 23	do	75	124	.40	1.74	49
September 23	do	75	124	.38	1.72	47
October 5	J. M. Giles	80	111	.38	1.69	43
October 5	do	40	36	1.41	1.70	50

MUCKALEE CREEK NEAR ALBANY, GA.

This station was established as a temporary station March 9, 1903, by F. A. Murray. It is located at the wagon bridge 3 miles north of Albany, Ga., and a short distance below the mouth of Kinchafoonee Creek. The gage is a vertical rod of 1 by 4 inch board nailed to a scantling, fastened to a tree on the left bank just above the bridge, and reads from zero to 14 feet. During 1903 it was read once each day by T. M. Nelson. Discharge measurements are made from the single-span highway bridge and its approaches. The initial point for soundings is the river side of the iron pier on the right bank, downstream side of the bridge. The channel is straight for 300 feet above the station and for 200 feet below. The current is regular and of

derate velocity. Both banks are high and will not overflow. The d is rocky and probably permanent. The river flows in one channel all stages. Backwater from Flint River affects the discharge at gh stages.

Bench mark No. 1 is the top of the upstream pier on the right bank; elevation is 27.65 feet above the zero of the gage. Bench mark . 2 is a copper plug set in a rock on the right bank about 40 feet low the bridge. Its elevation is 11.91 feet above the zero of the ge. The station was discontinued December 31, 1903, but has been aintained as a bench-mark station during 1904.

The observations at this station during 1904 have been made under e direction of M. R. Hall, district hydrographer.

Discharge measurements of Muckalee Creek near Albany, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
arch 6	F. A. Murray		992	5.18	6.60	5,141
ay 22	M. R. Hall		1,005	2.81	7.40	2,829
ly 2	F. A. Murray		582	2.53	1.88	1,473
ptember 19	do		907	4.62	6.22	4,195
tober 15	M. R. Hall		364	1.76	.72	644
cember 22	F. A. Murray		462	2.90	[1] 59	1,343
1904.						
ril 22	W. E. Hall	80	443	2.37	1.45	1,051
ne 18	B. S. Drane	80	350	1.20	.33	419
ptember 22	J. M. Giles	76	338	1.35	.35	455
vember 16	B. S. Drane	90	391	2.13	.95	832

KINCHAFOONEE CREEK NEAR ALBANY, GA.

This station was established as a temporary station March 9, 1903, F. A. Murray. It is located at the wagon bridge 3 miles north of lbany, Ga., 200 feet below the Central of Georgia Railroad bridge d about one-half mile above the mouth of the creek. The gage is vertical rod fastened to the cypress tree on the left bank 100 feet ove the bridge, and reads from zero to 10 feet. During 1903 it was ad once daily by T. M. Nelson. Discharge measurements are made om the single-span highway bridge and its approaches, which cross e river at an angle to the direction of the current. The initial point r soundings is the center of the iron pier on the left bank, downtream side. The channel is curved both above and below the station. oth banks are high and all water passes beneath the bridge and its pproaches. The bed is probably somewhat shifting.

Bench mark No. 1 is the top of the crossbeam 30 feet from the initial point for soundings on the upstream side of the bridge. Its elevation is 26.52 feet above the zero of the gage. Bench mark No. 2 is a copper plug set in a rock on the left bank about 25 feet below the bridge. Its elevation is 6.97 feet above the zero of the gage. Bench mark No. 3 is the top of the iron pier on the left bank, upstream side. Its elevation is 26.37 feet above the zero of the gage. The station was discontinued December 31, 1903, but has been maintained as a bench-mark station during 1904.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Kinchafoonee Creek near Albany, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 6	F. A. Murray		973	3.99	4.28	3,886
May 22	M. R. Hall		721	2.33	3.32	1,682
July 2	F. A. Murray		650	1.45	1.84	944
September 19	do		833	2.46	3.29	2,051
October 15	M. R. Hall		581	.73	.98	422
December 22	F. A. Murray		667	1.27	1.76	851
1904.						
June 18	B. S. Drane	88	594	.43	.62	256
September 22	J. M. Giles	66	462	.64	.65	296
November 16	B. S. Drane	89	649	.87	1.12	535

MISCELLANEOUS MEASUREMENTS IN APALACHICOLA RIVER DRAINAGE BASIN

The following is a list of miscellaneous discharge measurements made in Apalachicola River drainage basin during 1904:

Deep Creek near Clarksville, Ga.—This stream is a tributary of Soque River. A measurement was made May 13 from the wooden bridge on Burton road, about 3 miles from Clarksville.

Width, 25 feet; area, 26 square feet; mean velocity, 1.58 feet per second; discharge, 41 second-feet.

Beaverdam Creek near Clarksville, Ga.—This stream is a tributary of Soque River, entering from the right. A measurement was made May 13 from the bridge about 1 mile from Clarksville, on the road to Nacoochee, Ga. The bench mark is the top of the brace from hand-rail to large birch on the upper side of the bridge at the right bank, 12.00 feet above the datum of the gage.

Width, 22 feet; area, 12 square feet; mean velocity, 1.50 feet per second; gage height, 0.45 feet; discharge, 18 second-feet.

Hazel Creek near Demorest, Ga.—This stream is a tributary of que River, entering from the left. A measurement was made May from the bridge 1 mile from Demorest, on the road to Porter Mills. e bench mark is the top of the upper end of second floorbeam from e right bank, 15.00 feet above the datum of the gage.

Width, 25 feet; area, 30 square feet; mean velocity, 1.47 feet per second; gage ight, 1.85 feet; discharge, 44 second-feet.

Soque River near Clarksville, Ga.—Measurements were made from 'all's bridge, 2½ miles above Clarksville. The bench mark is the top a nail driven into a large leaning birch tree about 20 feet above the idge on the left bank, 6.00 feet above the datum of the gage.

March 17: Width, 36 feet; area, 65 square feet; mean velocity, 1.83 feet per second; ge height, 1.35 feet; discharge, 119 second-feet.
March 17: Width, 36 feet; area, 63 square feet; mean velocity, 1.82 feet per second; ge height, 1.35 feet; discharge, 115 second-feet.
May 13: Width, 36 feet; area, 62 square feet; mean velocity, 1.92 feet per second; ge height, 1.45 feet; discharge, 119 second-feet.

Soque River near Cornelia, Ga.—Measurements were made at IcHalister's bridge, about 7 miles from Cornelia and 1 mile above e mouth of the river. The bench mark is the top of the downstream d of the first wooden floor beam from the left bank, 22.00 feet above e datum of the gage.

March 18: Width, 74 feet; area, 152 square feet; mean velocity, 1.62 feet per second; ge height, 1.85 feet; discharge, 246 second-feet.
July 16: Width, 72 feet; area, 88 square feet; mean velocity, 1.47 feet per second; ge height, 1.25 feet; discharge, 130 second-feet.

Rottenwood Creek near Vinings, Ga.—This stream enters Chattaoochee River from the right. Measurements were made by wading t a point about 200 feet above the old Thornton dam, and 2 miles bove the mouth of the creek. The creek was believed to be at its west stage. The bench mark is a nail driven into rock on the right ank at the measuring section, marked "B. M." Its elevation is 3.00 et above the datum of the gage.

October 4: Width, 9 feet; area, 6 square feet; mean velocity, 0.84 foot per second; ge height, 0.26 foot; discharge, 4.8 second-feet.
October 4: Width, 9 feet; area, 6 square feet; mean velocity, 0.82 foot per second; ge height; 0.26 foot; discharge, 4.9 second-feet.
October 4: Width, 9 feet; area, 6 square feet; mean velocity, 0.72 foot per second; ge height, 0.25 foot; discharge, 4.3 second-feet.

North Fork of Peachtree Creek near Armour, Ga.—A measurement as made May 20, from the Cheshire Bridge, 1½ miles above the outhern Railway bridge at Armour, Ga. The bench mark is the top f a bent nail in the bottom of the twelfth rail post from the right nd of the bridge, 16.00 feet above the datum of the gage.

Width, 11 feet; area, 14 square feet; mean velocity, 1.71 feet per second; gage eight, 0.90 foot; discharge, 24 second-feet.

Pavine Creek near Armour, Ga.—This stream is the South Fork of Peachtree Creek. A measurement was made May 20, from the wooden bridge on the Cheshire Bridge road, about 1 mile east of Armour, Ga. The bench mark is the top of the head of the upper bolt used to bolt the second rail post from the right end of the bridge to the stringer at the lower side of the bridge. Its elevation is 16.00 feet above the datum of the gage.

Width, 14 feet; area, 13 square feet; mean velocity, 1.23 feet per second; gage height, 0.85 foot; discharge, 16 second-feet.

Peachtree Creek at Armour, Ga.—This stream is a tributary of Chattahoochee River. A measurement was made May 20 from the Southern Railway bridge. The bench mark is the top of the middle stringer at its center on the downstream side of the bridge, 15.00 feet above the datum of the gage.

Width, 27 feet; area, 27 square feet; mean velocity, 1.22 feet per second; gage height, 0.17 foot; discharge, 33 second-feet.

Peachtree Creek near Brookwood, Ga.—Measurements were made at the wagon bridge 1 mile north of Brookwood, on the Peachtree road, and 6 miles north of Atlanta, Ga. The bench mark is the top of the iron plate on the first upright from the right end of the bridge, downstream side, 28.00 feet above the datum of the gage.

May 20: Width, 43 feet; area, 25 square feet; mean velocity, 1.52 feet per second; gage height, 0.68 foot; discharge, 38 second-feet.

April 9: Width, 44 feet; area, 37 square feet; mean velocity, 1.54 feet per second; gage height, 1.12 feet; discharge, 57 second-feet.

Nickajack Creek near Nickajack, Ga.—This stream enters Chattahoochee River from the right, about 1 mile below the old gaging station at Oakdale, Ga. The bench mark is the top of the second upstream iron girder from the left end of the bridge, 12 feet from the end which rests on the center pier, 15.00 feet above the datum of the gage. Measurements were made by wading about 100 feet above the Southern Railway bridge.

October 8: Width, 16 feet; area, 10 square feet; mean velocity, 1.00 foot per second; gage height, 0.92 foot; discharge, 10 second-feet.

October 8: Width, 16 feet; area, 11 square feet; mean velocity, 1.19 feet per second; gage height, 0.94 foot; discharge, 12.6 second-feet.

Sweetwater Creek near Lithia Springs, Ga.—This stream enters Chattahoochee River from the right below the old station at Oakdale, Ga. A measurement was made March 15 at Adair's bridge, 2 miles north of Lithia Springs, and above the regular station on Sweetwater Creek near Austell, Ga. The bench mark is the top of the downstream end of the cap of first wooden bent from the left end of the bridge, 10.00 feet above the datum of the gage.

Width, 66 feet; area, 295 square feet; mean velocity, 1.37 feet per second; gage height, 1.50 feet; discharge, 404 second-feet.

Sweetwater Creek near Austell, Ga.—A measurement was made ırch 15 at Ferguson's mill bridge 5 miles from Austell. The bench ırk is a nail driven into the river side of a birch tree on the right ık 12 feet below the bridge, 5.00 feet above the datum of the gage.

Width, 129 feet; area, 484 square feet; mean velocity, 1.67 feet per second; gage ght, 1.50 feet; discharge, 807 second-feet.

Flint River near Montezuma, Ga.—A measurement was made Sepnber 21 at the highway bridge, about 1 mile northwest of Montema. The bench mark is the top of the upstream pier at the left nk, which was 26.15 feet above the water surface. The gage height ven is that taken from the temporary gage belonging to the United ıtes Weather Bureau.

Width, 188 feet; area, 1,300 square feet; mean velocity, 0.75 foot per second; gage ght, 10.63 feet; discharge, 971 second-feet.

Flint River near Concord, Ga.—A measurement was made Septemr 24 from the wooden bridge 5 miles from Concord. The bench ırk is the top of the first post from the right bank on the downream side of the bridge, 12.00 feet above the datum of the gage.

Width, 92 feet; area, 184 square feet; mean velocity, 0.43 foot per second; gage ight, 2.05 feet; discharge, 79 second-feet.

Flint River near Woodbury, Ga.—Measurements were made at ɔwell's bridge, 3 miles above the regular gaging station at Woodıry. The bench mark is the top of the right upstream post of first er from the right bank, 15.00 feet above the datum of the gage.

January 16: Width, 139 feet; area, 527 square feet; mean velocity, 1.39 feet per ɔond; gage height, 5.88 feet; discharge, 730 second-feet.
September 22: Width, 116 feet; area, 332 square feet; mean velocity, 0.43 foot per ɔond; gage height, 4.54 feet; discharge, 144 second-feet.
October 4: Width, 115 feet; area, 314 square feet; mean velocity, 0.34 foot per ɔond; gage height, 4.40 feet; discharge, 107 second-feet.

White Oak Creek near Riverview, Ga.—This stream enters Flint iver from the right, about 13 miles above the regular gaging station ı Flint River at Woodbury, Ga. A measurement was made March 9 at the double bridges one-half mile from Riverview. The bench ıark is the top of the first post, 9.00 feet above the datum of the gage.

Width, 61 feet; area, 222 square feet; mean velocity, 0.50 feet per second; gage eight, 2.36 feet; discharge, 112 second-feet.

White Oak Creek near Warnersville, Ga.—A measurement was ıade March 29 at the wagon bridge one-half mile west of Warnersille. The bench mark is the top of the first post on the downstream ide of the bridge, 13.00 feet above the datum of the gage.

Width, 38 feet; area, 163 square feet; mean velocity, 0.71 foot per second; gage eight, 1.25 feet; discharge, 115 second-feet.

Red Oak Creek near Woodbury, Ga.—This stream is tributary to 'lint River, from the right, 3 miles above the regular gaging station

on Flint River at Woodbury. The bench mark is the top of the first post from the right-bank edge, downstream side, 15 feet from a large white oak tree. Its elevation is 20.00 feet above the datum of the gage. Measurements have been made from the wagon bridge on the road to Concord, about 4 miles from Woodbury, 1 mile above the mouth of the creek, as follows:

January 16: Width, 68 feet; area, 134 square feet; mean velocity, 1.24 feet per second; gage height, 4.12 feet; discharge, 166 second-feet.

October 4: Width, 18 feet; area, 27 square feet; mean velocity, 0.68 foot per second; gage height, 2.65 feet; discharge, 18 second-feet.

Big Potato Creek near Thomaston, Ga.—Before the section now adopted as a regular bench-mark station was found, two measurements of Big Potato Creek were made at the covered wagon bridge, 2½ miles from Thomaston, just below the Macon and Birmingham Railroad trestle. The bench mark is the top of the downstream lower stringer at sounding point 80. The elevation above gage zero is 15.00 feet.

January 15: Width, 82 feet; area, 188 square feet; mean velocity, 0.85 feet per second; gage height, 3.30 feet; discharge, 160 second-feet.

March 31: Width, 72; area, 175 square feet; mean velocity, 0.74 feet per second; gage height, 3.25 feet; discharge, 130 second-feet.

Blue Spring near Albany, Ga.—This spring is of considerable local note. It is about one-half mile from the left bank of Flint River, and about 4 miles below Albany, Ga. Measurements were made from the foot log over the outlet of the main spring as follows:

April 19: Width, 25 feet; area, 45 square feet; mean velocity, 3.00 feet per second; gage height, 3.29 feet; discharge, 135 second-feet.

September 23: Width, 28 feet; area, 30 square feet; mean velocity, 1.47 feet per second; gage height, 2.85 feet; discharge, 44 second-feet.

November 16: Width, 22 feet; area, 21 square feet; mean velocity, 1.24 feet per second; gage height, 2.77 feet; discharge, 26.4 second-feet.

CHOCTAWHATCHEE DRAINAGE BASIN.

Choctawhatchee River drains the southeastern part of Alabama, and that portion of Florida lying immediately south. The main river rises in Barbour County, Ala., a short distance west of Eufaula, Ala., and flows in a southwesterly and southerly direction through the Choctawhatchee Bay to the Gulf of Mexico. Pea River is the principal tributary and enters from the west at Geneva, Ala. This branch is the longer of the two, measured above their junction, having its head in Bullock County near Union Springs, Ala. Double Bridges Creek is an important but small tributary lying between the main branches, and entering Choctawhatchee River just above the mouth of Pea River. These are all moderately swift streams, even at low water, and at places the fall is sufficient to make considerable shoals or rapids, and offer practicable sites for water-power developments. During 1904 the

United States Geological Survey established and maintained gaging stations on Choctawhatchee River near Geneva, Ala.; on Pea River at Pera, Ala., and on Double Bridges Creek at Geneva, Ala.

CHOCTAWHATCHEE RIVER NEAR GENEVA, ALA.

This station was established August 26, 1904, by M. R. Hall. It is located at a wagon bridge about 1 mile from Geneva and one-fourth mile from Eunola, Ala. The gage is an 8-foot vertical scale, graduated to feet and tenths, reading from 1 to 9 feet, and continued on the 2 by 6 inch scantling to which it is attached. This scantling is fastened to the upstream side of a heavy pile, which was a part of the right bent of the old bridge which occupied the same site as the new one. This pile is the second from the downstream end of a line of 5 set up and down stream. The gage is read once each day by James McGowan. Discharge measurements are made from the downstream side of the three-span iron drawbridge, having about 50 feet of trestle approach on either end. The initial point for soundings is the left end of the iron bridge on the downstream side. The channel is straight for 200 feet above and for one-half mile below the bridge. The current has a fair velocity. The right bank is a sand bluff about 27 feet high. There are a few trees on the face of the bluff and the top is wooded. The left bank is an overhanging rock cliff to a height of about 10 feet, above which it is sandy and slopes gradually to a total height of about 27 feet. Both banks are subject to overflow. The bed of the stream is composed of firm sand for the greater part, there being some rock at the left bank, and is clean and permanent. There is one channel at all but very high stages, when both banks overflow, and a second channel is formed by lower ground some distance from river on the right bank. The station is about three-fourths mile above the mouth of Double Bridges Creek and is also near the junction with Pea River. Backwater from both of these streams will affect the gage heights during times of unequal rise, and the station is maintained only temporarily for low-water measurements. Bench mark No. 1 is the top of the downstream end of the fourth floor beam from the right end of the bridge, this being the first beam from the left end of the span. Its elevation is 32.00 feet above the zero of the gage. Bench mark No. 2 is a large wire nail in the river side of a cypress tree on the right bank, about 140 feet below the bridge. Its elevation is 12.07 feet above the zero of the gage.

The station was discontinued on December 31, 1904.

Discharge measurements of Choctawhatchee River near Geneva, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 27	M. R. Hall	111	418	1.54	2.07	642
June 21	B. S. Drane	117	369	1.26	1.63	464
August 26	M. R. Hall	120	801	1.34	4.18	1,073
September 26	J. M. Giles	102	322	1.50	1.38	483
September 26	do	102	313	1.47	1.36	461
November 18	B. S. Drane	118	395	1.62	1.81	643
November 18	do	118	397	1.60	1.81	635

Mean daily gage height, in feet, of Choctawhatchee River near Geneva, Ala., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.50	1.40	1.25	1.85	17		1.70	1.15	1.85	2.70
2		3.30	1.50	1.40	2.40	18		1.70	1.20	1.90	2.90
3		2.85	1.30	2.05	6.10	19		1.65	1.30	1.75	2.80
4		2.45	1.25	2.40	5.50	20		1.65	1.25	1.80	2.70
5		2.50	1.30	2.10	4.95	21		1.60	1.25	1.70	2.70
6		2.75	1.30	1.80	6.65	22		1.50	1.30	1.85	2.60
7		2.80	1.45	1.75	5.75	23		1.50	1.25	2.40	2.50
8		3.20	1.55	1.70	4.45	24		1.60	1.10	2.30	2.50
9		2.90	1.45	1.75	3.85	25		1.55	1.10	2.10	2.50
10		2.60	1.30	1.60	3.50	26	4.20	1.40	1.25	2.00	2.55
11		2.45	1.30	1.65	3.40	27	4.30	1.45	1.30	1.90	4.40
12		2.10	1.30	1.50	3.20	28	5.80	1.50	1.30	1.75	6.90
13		2.00	1.35	1.95	2.90	29	6.20	1.45	1.30	1.80	5.50
14		1.90	1.30	2.20	2.85	30	4.50	1.45	1.30	1.80	5.40
15		1.80	1.25	1.95	2.80	31	3.90		1.25		5.45
16		1.80	1.25	1.90	2.50						

DOUBLE BRIDGES CREEK AT GENEVA, ALA.

This station was established August 26, 1904, by M. R. Hall. It is located at the wagon bridge on the outskirts of Geneva, Ala., about three-fourths mile above the mouth of the creek. The gage is a vertical scale 9 feet long graduated to feet and tenths bolted to a 2-inch by 6-inch scantling which is spiked to the upstream side of a cypress tree on the left bank about 100 feet below the bridge. It is read once each day by James McGowan. Discharge measurements are made from the upstream side of the single span, iron bridge to which the gage is attached. The initial point for soundings is the upstream side of the left end of the iron bridge. The channel is curved for about 200 feet above, and straight for about 600 feet below the station. The current has a good velocity. Both banks are about 15 or 17 feet high, wooded except at bridge, and are subject to overflow. The bed of

stream is composed of sand, and is clean except near the right ι where a half buried tree forms an obstruction. There is but channel at all stages.

uring high water the gage heights are affected by back water ı Choctawhatchee River, and the station is maintained only tempo- ly for low-water measurements. Bench mark No. 1 is the bottom he upstream end of the first floor beam from the left end of the ge. Its elevation is 19.80 feet above the zero of the gage. Bench k No. 2 is a chisel cut and white paint mark on the intermediate 6 feet above bench mark No. 1. Its elevation is 25.80 feet above zero of the gage.

Discharge measurements of Double Bridges Creek at Geneva, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
27	M. R. Hall	45	90	1.38	1.61	124
21	B. S. Drane	45	81	1.22	1.24	99
ıst 26	M. R. Hall	62	244	2.59	4.63	633
ember 26	J. M. Giles	47	78	1.08	1.45	84
ember 26	do	47	94	1.22	1.82	115
ember 18	B. S. Drane	49	83	1.22	1.52	101
ember 18	do	49	94	1.22	1.60	115

Mean daily gage height, in feet, of Double Bridges Creek at Geneva, Ala., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
		3.10	1.35	1.45	1.40	17		1.40	.90	1.60	2.35
		2.50	1.25	1.80	3.35	18		1.65	1.10	1.70	2.60
		2.20	1.00	2.70	5.90	19		1.75	1.20	1.40	2.30
		2.10	1.00	2.70	4.80	20		1.30	1.05	1.60	2.00
		2.10	1.30	2.10	5.25	21		1.30	.85	1.60	1.95
		2.40	1.05	1.70	5.40	22		1.20	.90	1.70	2.05
		2.50	1.45	1.65	4.30	23		1.55	1.10	2.45	1.90
		2.85	1.70	1.40	2.95	24		1.35	.90	2.30	2.10
		1.85	1.05	1.30	2.50	25		1.45	1.00	1.90	1.90
		1.90	1.15	1.15	2.75	26		1.25	.90	1.45	2.05
		1.80	1.15	1.40	2.60	27	4.90	1.40	1.05	1.75	2.05
		1.60	1.05	1.45	2.50	28	5.50	1.30	1.10	1.15	4.80
		1.40	1.15	2.40	2.00	29	4.60	1.30	1.30	1.70	4.80
		1.50	1.10	2.05	2.10	30	3.00	1.35	1.40	1.60	3.30
		1.30	.85	1.75	2.15	31	3.00		1.10		2.60
		1.40	1.10	1.60	2.05						

PEA RIVER AT PERA, ALA.

This station was established August 27, 1904, by M. R. Hall. It is ated at the Elton wagon bridge, about one-half mile west of Pera,

Ala., a station on the Georgiana and Graceville Branch of the Louisville and Nashville Railroad. A chain gage is fastened to the top plank of the upstream fencing of the bridge, with the pulley end of the box abutted against the intermediate post over the second floor beam from the right bank. The scale is attached to the top of the plank. The length of the chain from the end of the weight to the marker is 48.20 feet. The gage is read once each day by W. G. Early, who is paid by the Alabama Geological Survey. Discharge measurements are made from the downstream side of the single-span bridge to which the gage is attached. The initial point for soundings is the outside of the downstream tubular iron pier at the right bank. The channel curves to the left about 150 feet above the station, which tends to throw the greatest current velocity along the right bank, and is straight below the station for about 1,000 feet. The current has a fair velocity. The right bank is composed of rock, vertical for about 20 feet from low-water level, and is free from vegetation. The left bank is composed of sand and mud, rising gradually. It is wooded above and below, but cleared at the bridge. Both banks are subject to overflow during extreme high water. The bed of the stream is composed of smooth rock toward the right bank and sand toward the left. There is one channel at all stages. Bench mark No. 1 is the top of the downstream end of the first floor beam from the right pier. Its elevation is 42.00 feet above gage datum. Bench mark No. 2 is a chisel mark on the intermediate post at downstream end of the first floor beam from right bank, 5 feet above bench mark No. 1. Its elevation is 47.00 feet above the datum of the gage. Bench mark No. 3 is the top of the upstream end of the second floor beam from the right bank. Its elevation is 42.03 feet above the datum of the gage. Bench mark No. 4 is a chisel mark on the post 4.97 feet above bench mark No. 3. Its elevation is 47.00 feet above gage datum.

Discharge measurements of Pea River at Pera, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 26	M. R. Hall	68	319	0.89	2.47	285
June 22	B. S. Drane	67	263	.74	1.80	194
August 27	M. R. Hall	81	446	1.77	4.66	790
September 27	J. M. Giles	64	161	1.18	1.59	190
September 27	do	64	157	1.20	1.60	189
November 17	B. S. Drane	70	204	1.50	2.32	307
November 17	do	70	206	1.49	2.34	308

Mean daily gage height, in feet, of Pea River at Pera, Ala., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.3	1.6	1.3	2.2	17	.....	2.3	1.3	2.2	3.3
2	.....	4.5	1.4	1.4	3.2	18	.....	2.1	1.3	2.2	3.4
3	.....	3.9	1.4	2.0	5.3	19	.....	1.9	1.4	2.1	3.5
4	.....	3.3	1.4	2.2	4.4	20	.....	1.5	1.4	2.2	3.4
5	.....	3.5	1.4	2.1	6.1	21	.....	1.6	1.4	2.1	3.3
6	.....	3.6	1.4	2.2	7.6	22	.....	1.8	1.4	2.3	3.3
7	.....	4.6	2.1	2.1	6.1	23	.....	1.5	1.3	2.6	3.2
8	.....	4.8	1.7	2.0	5.4	24	.....	1.4	1.2	2.4	3.1
9	.....	3.7	1.6	2.0	5.0	25	.....	1.6	1.2	2.4	3.0
10	.....	3.4	1.5	1.9	4.5	26	.....	1.5	1.3	2.4	3.2
11	.....	3.0	1.6	2.0	4.2	27	4.7	1.6	1.4	2.3	4.9
12	.....	2.8	1.6	1.8	4.0	28	6.9	1.6	1.3	2.3	7.6
13	.....	2.6	1.5	2.2	3.7	29	7.5	1.6	1.4	2.3	8.0
14	.....	2.4	1.5	2.3	3.6	30	7.1	1.6	1.4	2.2	7.0
15	.....	2.2	1.4	2.4	3.4	31	6.2	.....	1.4	.....	6.5
16	.....	2.3	1.5	2.3	3.3						

ESCAMBIA RIVER DRAINAGE BASIN.

Escambia River drains the south-central portion of Alabama and empties into the Gulf of Mexico through Escambia Bay and Pensacola Bay. Conecuh River joins the Escambia about 5 miles south of the Alabama-Florida State line, and is very much the larger of the two branches. Conecuh River rises in Bullock County, Ala., very close to the headwaters of Pea River in the Choctawhatchee drainage, and flows southwesterly throughout its course. Pigeon and Patsaliga creeks, both from the west, are the principal tributaries of Conecuh River. The Conecuh and its tributaries are swift streams and at places there are rocky shoals or rapids. During 1904 the United States Geological Survey established and maintained a gaging station on Conecuh River at Beck, near Andalusia, Ala.

CONECUH RIVER AT BECK, ALA.

This station was established August 24, 1904, by M. R. Hall. It is located at Simmons Bridge at Beck, Ala., and about 12 miles below the mouth of Patsaliga Creek. The nearest railway station is Andalusia, Ala., 8 miles east, on the Central of Georgia and Louisville and Nashville railways. A chain gage is fastened to the channel-iron fencing post which is riveted to the upstream end of the first floor beam of the main span, 72 feet from the initial point for soundings. The gage box and scale are bolted to a 2-inch by 6-inch scantling, which is bolted horizontally to this post and the main end post. The length of the chain from the end of the weight to the marker is 53.50 feet. The gage is read once each day by W. R. Duggan, who is paid by the Ala-

bama Geological Survey. Discharge measurements are mad the upstream side of the iron bridge to which the gage is att The bridge consists of a main span 125 feet long with a 50-foot s each end. The approach on the right bank is 50 feet of wood 90 feet of iron trestle; on the left bank, 20 feet of wooden t The initial point for soundings is the end of the iron bridge at t bank on the upstream side. The channel is straight for 60 above and for about one-half mile below the station. The cur fairly swift. Both banks are steep. The right bank is compo rock to a height of about 8 feet, then earth covered with bush total height of about 30 feet, and is subject to overflow. Tl bank is composed of rock to a height of from 15 to 20 feet, ther covered with bushes to a total height of about 35 feet, and overflow at extreme high water. The bed of the stream is composed sand, there being some smooth rock along the left bank. The some sunken logs in the section which obstruct the current to extent. There is one channel at all stages. Bench mark No. 1 top of the upstream end of the first iron floor beam of the mai from the left pier. Its elevation is 47.50 feet above gage c Bench mark No. 2 is the top of the iron channel-bar post to whi gage is fastened. Its elevation is 52.17 feet above the zero of the

Discharge measurements of Conecuh River at Beck, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Di
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Sec*
May 26	M. R. Hall	110	274	1.17	1.67	
June 24	B. S. Drane	109	231	1.03	1.18	
August 24	M. R. Hall	115	392	1.50	2.63	
September 28	J. M. Giles	108	232	1.06	1.20	
September 28	do	108	237	1.03	1.20	
November 19	B. S. Drane	111	245	1.19	1.40	
November 19	do	111	245	1.18	1.40	

Mean daily gage height, in feet, of Conecuh River at Beck, Ala., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.50	1.10	0.80	1.50	17	.....	1.30	0.85	1.40	2.20
2	.....	2.80	1.00	.90	2.30	18	.....	1.40	.90	1.40	2.20
3	.....	2.90	1.00	1.45	2.60	19	.....	1.20	.95	1.40	2.10
4	.....	5.35	.70	1.40	2.65	20	.....	1.20	.95	1.35	2.00
5	.....	4.10	.80	1.25	4.00	21	.....	1.00	.80	1.35	2.00
6	.....	3.40	.85	1.25	3.70	22	.....	1.40	.80	1.70	1.80
7	.....	2.90	1.30	1.30	3.35	23	.....	1.30	.80	1.85	1.75
8	.....	2.30	1.00	1.35	3.30	24	3.60	1.20	.85	1.50	1.75
9	.....	2.20	1.00	1.35	3.00	25	4.70	1.20	.90	1.80	1.80
10	.....	2.20	1.05	1.30	2.90	26	3.10	1.00	.90	1.85	1.85
11	.....	2.00	.85	1.30	2.80	27	2.90	1.00	.90	1.70	1.95
12	.....	1.70	1.00	1.15	2.50	28	5.70	1.05	.90	1.70	4.40
13	.....	1.80	.95	1.35	2.40	29	4.50	1.05	.90	1.60	3.50
14	.....	1.60	.95	1.40	2.35	30	4.00	1.10	.85	1.60	3.60
15	.....	1.60	.80	1.20	2.20	31	3.50	.....	.85	.....	3.50
16	.....	1.50	.80	1.20	2.20						

MOBILE RIVER DRAINAGE BASIN.

This is the largest drainage basin in Georgia and Alabama, and is designated the Mobile basin because its waters all enter the Gulf through Mobile River at Mobile, Ala. It is formed as follows: Beginning at the headwaters, Cartecay and Ellijay rivers unite at Ellijay, Ga., to form Coosawattee River. Just above Resaca, Ga., this unites with the Conasauga to form Oostanaula River. At Rome, Ga., the Oostanaula and the Etowah unite to form Coosa River. Six miles above Montgomery, Ala., the Coosa and the Tallapoosa unite to form Alabama River; and not far from the coast the Tombigbee unites with the Alabama to form Mobile River, which flows into Mobile Bay, an arm of the Gulf of Mexico.

Cahaba River is the principal tributary of the Alabama and joins it about 10 miles below Selma. Hillabee Creek flows into Tallapoosa River just above Sturdevant and near Alexander. Talladega Creek is a tributary of the Coosa.

Tombigbee River rises in the northeastern part of Mississippi and enters Alabama in Pickens County. Its principal tributary is the Black Warrior, which is formed by the junction of Mulberry Fork and Sipsey Fork. Locust Fork enters the Black Warrior some distance below the junction.

The following pages give the results of the data collected in this drainage during 1904:

ALABAMA RIVER AT SELMA, ALA.

This station, which was originally established by the United States Engineer Corps, is now maintained by the United States Weather

Bureau. The station is at the iron highway bridge one block from Water street, Selma, Ala. The gage is in two sections. The first section, reading from − 3 to + 5.1 feet, is fastened to the lower side of the cofferdam on the second pier; the upper section, reading from 5.1 to 55 feet, is bolted to the draw pier. Discharge measurements are made from the bridge and the trestle approach on the left bank. The initial point for soundings is the end of the drawbridge on the right bank, upstream side. The channel above the station is slightly curved for 1,000 feet and straight for 2,000 feet below the station. The velocity is good and the current is regular. The right bank is high and rocky and will not overflow. The left bank is high, but overflows at extreme high water. The bed is mostly soft blue rock, and the water is confined to one channel. Bench mark No. 1 is an iron bolt driven into the rock bluff 182 feet from the first pier on the road leading up from the boat landing; its elevation is 26.00 feet above the zero of the gage and 88 feet above mean sea level. Bench mark No. 2 is the top of the capstone of the pivot pier. Its elevation is 56.00 feet above the zero of the gage. Bench mark No. 3 is the edge of the coping on the right bank abutment, just under the downstream side of the drawbridge; its elevation is 59.51 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Alabama River at Selma, Ala., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
April 10 [a]	J. M. Giles	497	12,600	4.69	22.35	59,100
June 19 [a]	do	401	5,461	3.44	6.45	18,820
November 11 [a]	do	258	3,298	2.51	1.00	8,290
1904.						
January 22 [b]	J. M. Giles	397	4,864	3.33	5.20	16,200
January 23 [b]	do	402	5,059	3.37	5.55	17,050
April 8 [b]	do	386	4,746	2.74	4.20	13,010
August 5 [b]	do	391	5,131	2.85	4.60	14,600
August 5 [b]	do	391	5,100	2.74	4.30	13,970
November 1 [a]	do	235	2,473	1.08	−2.20	2,665
November 1 [a]	do	235	2,492	1.12	−2.20	2,786

[a] Wagon bridge. [b] Measured at Louisville and Nashville Railroad bridge.

Mean daily gage height, in feet, of Alabama River at Selma, Ala., for 1904.

r.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.6	4.7	8.3	7.4	2.0	0.0	0.5	1.5	2.9	−1.3	−1.8	−0.9
.....	1.1	4.0	7.0	6.5	2.1	1.3	3.9	2.0	2.0	−1.4	−1.8	− .9
.....	1.0	3.8	6.1	5.7	2.1	2.8	2.8	3.6	1.6	−1.4	−1.8	− .9
.....	1.0	3.8	5.7	5.1	2.0	3.0	2.6	4.5	1.2	−1.4	−1.6	− .8
.....	1.0	3.6	5.5	4.6	1.9	2.8	2.6	4.8	1.2	−1.5	−1.6	− .6
.....	.9	3.5	5.4	4.2	1.6	2.6	1.9	3.5	.9	−1.6	−1.6	− .1
.....	.9	4.0	5.4	4.0	1.4	2.7	2.0	4.8	.6	−1.6	−1.6	.4
.....	1.0	6.8	6.1	4.2	1.2	2.3	1.7	8.7	.3	−1.7	−1.6	.7
.....	1.0	11.0	9.7	5.1	1.2	2.0	1.5	16.4	.3	−1.8	−1.8	2.0
.....	1.9	15.6	11.0	6.5	1.2	2.2	.8	22.5	.4	−1.8	−1.8	3.4
.....	2.6	19.6	10.8	7.4	1.1	2.2	1.3	22.9	.3	−1.8	−1.6	4.0
.....	3.9	21.0	10.0	7.0	1.1	1.4	1.3	20.3	.2	−1.8	−1.6	4.5
.....	5.2	21.5	9.0	7.2	1.1	.8	1.3	17.5	− .2	−1.8	−1.4	4.5
.....	4.0	19.9	7.9	7.2	.8	.7	.9	15.6	− .4	−1.8	−1.4	4.0
.....	3.6	17.0	7.0	6.4	1.4	.5	1.7	11.0	− .8	−1.8	−1.4	3.0
.....	2.7	13.0	7.3	5.2	1.6	.2	2.0	9.1	− .9	−1.8	−1.4	2.5
.....	2.8	9.9	9.4	4.1	1.6	.0	.8	7.5	− .9	−1.8	−1.4	2.0
.....	3.7	7.6	11.0	3.8	1.4	− .3	.5	6.6	−1.0	−1.8	−1.4	1.5
.....	4.1	6.1	11.3	3.1	1.0	− .3	− .1	5.8	−1.0	−1.8	−1.4	1.0
.....	5.1	5.7	10.1	2.9	1.0	− .4	− .3	5.2	−1.2	−1.8	−1.4	1.0
.....	4.5	6.0	8.9	2.8	.8	− .5	− .1	4.0	−1.2	−1.8	−1.4	.5
.....	4.7	7.0	7.5	2.5	.5	− .6	.0	3.5	−1.3	−1.8	−1.4	.5
.....	5.6	8.3	6.5	2.3	.5	−1.1	.1	2.7	−1.3	−1.8	−1.2	− .5
.....	10.9	10.0	5.7	2.1	.2	−1.1	.6	2.0	−1.3	−1.8	−1.0	−1.4
.....	12.9	11.8	5.1	2.1	.0	−1.1	.8	1.8	−1.4	−1.8	− .6	−1.6
.....	12.0	12.0	5.8	2.0	.0	−1.1	.8	2.5	−1.4	−1.8	− .6	−1.6
.....	10.9	12.6	8.0	1.9	− .2	−1.0	.7	3.0	− .9	−1.8	− .6	−1.6
.....	9.7	10.8	9.4	1.9	− .4	− .6	.5	4.0	− .4	−1.8	− .6	.0
.....	8.1	9.7	9.7	1.9	− .5	− .3	.4	3.7	− .7	−1.8	− .8	1.0
.....	6.6	.....	9.2	1.9	− .5	− .3	.8	4.0	−1.2	−1.8	− .9	6.4
.....	5.4	.....	8.3	.....	− .2	.....	.9	3.8	.....	−1.8	.....	6.7

g table for Alabama River at Selma, Ala., from January 1 to December 31, 1904.

e nt.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
t.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
20	2,700	−0.80	4,820	1.00	7,800	7.50	20,700
10	2,850	− .70	4,980	1.50	8,700	8.00	21,800
00	3,000	− .60	5,140	2.00	9,600	8.50	22,900
.90	3,150	− .50	5,300	2.50	10,550	9.00	24,000
.80	3,300	− .40	5,460	3.00	11,500	10.00	26,300
.70	3,450	− .30	5,620	3.50	12,450	11.00	28,600
.60	3,600	− .20	5,780	4.00	13,400	12.00	31,000
1.50	3,750	− .10	5,940	4.50	14,400	13.00	33,450
1.40	3,900	0.00	6,100	5.00	15,400	14.00	36,000
1.30	4,050	.20	6,440	5.50	16,450	15.00	38,600
1.20	4,200	.40	6,780	6.00	17,500	16.00	41,300
1.10	4,350	.60	7,120	6.50	18,550	17.00	44,000
1.00	4,500	.80	7,460	7.00	19,600	18.00	46,700
.90	4,660						

The preceding table is fairly well defined to gage height 3.4 feet. The table has been extended beyond this limit. It is based upon discharge measurements made during 1900–1904. Above gage height 18 feet the rating curve is a tangent, the difference being 275 per tenth.

Estimated monthly discharge of Alabama River at Selma, Ala., for 1904.

[Drainage area, 15,400 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	33,200	7,630	14,830	0.963	1.11
February	56,320	12,450	27,160	1.76	1.90
March	29,320	15,610	21,890	1.42	1.64
April	20,480	9,420	14,130	.918	1.02
May	9,790	5,300	7,726	.502	.579
June	11,500	4,350	7,259	.471	.526
July	13,210	5,620	8,088	.525	.605
August	60,180	8,700	21,510	1.40	1.61
September	11,310	3,900	5,865	.381	.425
October	4,050	3,300	3,421	.222	.256
November	5,140	3,300	3,981	.258	.288
December	18,970	3,600	8,467	.550	.634
The year	60,180	3,300	12,030	.781	10.59

ETOWAH RIVER AT CANTON, GA.

This station was established in 1892 by the United States Weather Bureau. Measurements were begun in 1896 by the United States Geological Survey. It is located at the wagon bridge in Canton, Ga., one-half mile above the mouth of Canton Creek and 1,000 feet upstream from the Atlanta, Knoxville and Northern Railway station. The gage is a heavy vertical timber, bolted to the edge of the left-bank pier, on the upstream side. The foot marks are numbered with brass figures. The gage is read once each day by J. M. McAfee, who is paid by the United States Weather Bureau for six months of the year and by the Georgia Geological Survey for the other six months. Discharge measurements are made from the upstream side of the iron highway bridge, which is about 25 feet above low water, and to which the gage is attached. The initial point for soundings is the river side of the right-bank pier at the end of the main span. The channel is straight for 1,000 feet above and 500 feet below the bridge. The current is affected by a fish-trap dam about 1 foot high, which was constructed in 1902, and which has since caused some trouble by being occasionally washed away and built

ain. Up to 3 feet gage height the river is only 116 feet wide and between the piers on its lower banks. Up to about 14 feet it is ed between its upper banks, which are the abutments at the outer f the approaches. Above this point it begins to overflow the n lands. The bed is fairly constant.

ch mark No. 1 is a cut on a silver maple tree on the east side of ad, 20 feet from the end of the bridge on the south or left bank river; its elevation is 20.36 feet above the zero of the gage. mark No. 2 is a cut on a persimmon tree 4 feet from the upper f the bridge and 10 feet toward the river from the south end of idge; its elevation is 16.88 feet above the zero of the gage. Bench No. 3 is the center of the head of a large wire nail, driven hori- ly in the side (toward the river) of a walnut tree on the east side road, 25 feet north of the north end of the bridge; its elevation 2 feet above the zero of the gage. Bench mark No. 4 is the top of on bar on the top of the left-bank pier at the end of the center f the bridge; its elevation is 23.39 feet above the zero of the gage. observations at this station during 1904 have been made under rection of M. R. Hall, district hydrographer.

Discharge measurements of Etowah River at Canton, Ga., in 1903 and 1904.

ate.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
03.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
y 28	M. R. Hall		568	1.62	1.07	922
27	O. P. Hall		765	3.35	2.50	2,562
7	E. C. Murphy		669	2.80	1.80	1,873
	M. R. Hall		563	2.07	.94	1,166
	do		563	1.99	.93	1,119
ber 4	do		520	1.10	.51	570
ber 4	do		523	1.10	.51	575
r 10	do		525	.98	.60	513
04.						
y 15	M. R. Hall	114	531	1.02	.50	542
3	O. P. Hall	113	529	1.55	.78	821
	do	108	460	1.08	.18	497
	M. R. Hall	105	437	.75	.04	328
	do	105	438	.74	.04	324
ber 1	O. P. Hall	109	437	.86	.06	374
r 8	M. R. Hall	105	398	.50	-.38	197
r 8	do	105	414	.55	-.25	227
r 13	O. P. Hall	107	385	.45	-.38	171

Mean daily gage height, in feet, of Etowah River at Canton, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.4	0.6	0.7	0.6	0.5	1.3	0.5	0.5	0.1	−0.4	0.0	0.
2	.4	.6	.7	.6	.4	.6	.4	1.2	.1	− .4	.1	.
3	.4	.6	.9	.6	.3	.3	.3	1.2	.1	− .3	.2	.
4	.4	.6	.7	.4	.3	.1	.2	.5	.3	− .3	.3	.
5	.4	.6	.7	.4	.3	.0	.6	2.5	.3	− .4	.4	.
6	.4	.6	.7	.4	.2	.0	.4	.8	.3	− .3	.3	2
7	.5	.7	2.1	.7	.2	.5	.2	.4	.1	− .3	.2	.
8	.5	1.6	1.7	1.0	.8	.2	.3	8.0	.0	− .3	.2	
9	.5	1.0	.9	.9	1.1	.0	.1	4.0	.0	− .4	.2	
10	.5	.6	.8	.8	.6	− .1	.0	1.0	.0	− .4	.2	
11	.6	.6	.8	.7	.3	− .1	.0	.8	− .1	− .3	.2	
12	.6	.6	.8	.7	.3	− .1	.2	1.1	− .1	− .3	.2	
13	.6	.7	.8	.6	.3	− .1	.8	.8	− .2	− .4	.4	
14	.6	.7	2.0	.5	.3	− .1	.3	.5	− .1	− .3	.6	
15	.5	.7	1.2	.5	.3	− .2	.1	.4	− .2	− .4	.4	
16	.5	.7	.8	.5	.2	− .2	.0	.3	− .3	− .3	.3	
17	1.1	.7	.8	.5	.2	− .2	.5	.3	− .3	− .3	.3	
18	.9	.6	.7	.5	.2	− .2	.2	.2	− .3	− .3	.3	
19	.7	.8	.7	.5	.2	− .3	.4	.1	− .3	− .3	.3	
20	.6	2.5	.6	.5	.1	− .3	.0	.2	− .3	− .3	.3	
21	.5	1.2	.6	.5	.1	.2	.0	.2	− .3	− .3	.3	
22	.7	2.6	1.2	.6	.0	.1	− .1	.0	− .3	− .2	.4	
23	1.7	1.0	.6	.5	.0	− .2	.1	.1	− .3	− .1	.7	
24	1.0	1.0	.6	.4	.0	− .3	.1	.7	− .4	− .2	.5	
25	.7	.8	.8	.4	.0	.1	.0	.5	− .4	− .1	.4	
26	.7	.8	.8	.5	− .1	.0	.1	.3	− .4	.0	.3	
27	.7	.7	.8	.5	− .1	− .1	− .1	.4	− .4	.0	.3	
28	.7	.6	.7	.5	− .2	.1	.0	.3	− .2	.0	.3	
29	.8	.6	.7	.5	− .3	.6	.0	.1	− .2	.0	.3	
30	.7	.....	.7	.5	− .3	3.8	.0	.1	− .3	.0	.3	
31	.6	.....	.6	.....	1.3	.....	.0	.0	.....	.0	.....	

Rating table for Etowah River at Canton, Ga., from January 1 to December 31, 1904

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.50	170	−0.10	280	0.30	470	0.70	755
− .40	190	.00	320	.40	532	.80	840
− .30	215	.10	365	.50	600	.90	930
− .20	245	.20	415	.60	675	1.00	1,020

The above table is based upon discharge measurements made during 1902 to 19
It is well defined between gage heights −0.5 foot and 1 foot. Estimates ab
1-foot gage height are based on a tangent, the difference being 90 per tenth.

Estimated monthly discharge of Etowah River at Canton, Ga., for 1904.

[Drainage area, 604 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	1,650	532	720	1.19	1.37
.....	2,460	675	916	1.52	1.64
.....	2,010	675	914	1.51	1.74
.....	1,020	532	650	1.08	1.20
.....	1,290	215	469	.776	.895
.....	3,540	215	479	.793	.885
.....	840	280	418	.692	.798
.....	7,320	320	979	1.62	1.87
er.....	470	190	278	.460	.513
.....	320	190	236	.391	.451
er.....	755	320	480	.795	.887
r	2,370	532	724	1.20	1.38
ie year	7,320	190	605	1.00	13.63

ETOWAH RIVER NEAR ROME, GA.

station was established August 17, 1904, by M. R. Hall. It is at Freeman's ferry, about 5 miles above Rome, Ga. The gage hree sections. The first section is the original gage, reading ero to 7 feet, securely attached to a sycamore tree at left edge r, about 250 feet below the ferry. The second section, reading to 20 feet, is attached to a chestnut post located 10 feet upstream he first section and 10 feet from the edge of the river (low , post about 10 inches in diameter and 21 feet long, the bottom post extending to firm gravel, 1.50 feet below low-water sur- The hole is filled with stone and about one-third concrete, the e being at the bottom and near the surface of ground, 7 feet he bottom of the post. The third section, reading from 20 to , is attached to a maple tree opposite post, and 15 feet farther he water's edge. Each section of the gage is of 1¼ by 2½ inch ine, well painted, and graduated by V-shaped grooves, which nted black. The gage is made up in 5-foot lengths, all of which urely fastened to substantial supports. The gage is read once y by Frank B. Freeman, who is paid by the Georgia Geological . Discharge measurements are made from a small boat, the eing suspended from the ferry cable. Measurements can be

made from the bridge at Rome, as no large quantity of water enters the river between the ferry and that place. Gage heights may be obtained at Rome by telephoning the observer. The initial point for soundings is the center of the windlass for the ferry cable on the left bank of the river. The channel is straight for about 3,000 feet above and for 1,000 feet below the station. The current is swift. There is a small shoal of rock about 50 feet below the gaging section. About 1,000 feet below there is an old fish-trap dam, but this has not been used for years and is probably constant. Both banks are high, but are subject to overflow during high water. The bed of the stream is composed of small rock and pebbles, and is uniform and permanent. There is but one channel at all stages, the water being about 2.5 feet deep at low water.

Bench mark No. 1 is head of lag screw driven in root of maple to which gage 20 to 30 feet is attached; elevation is 19.26 above datum. Bench mark No. 2 is head of nail driven in root at base of maple tree, 100 feet up river from gage; elevation, 22.18 feet. Bench mark No. 3 is center mark on copper plug set horizontally in brick wall of F. B. Freeman's residence, on east end of house, near northeast corner, just below floor level; elevation, 27.99 feet above datum.

Discharge measurements of Etowah River near Rome, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
August 18 [a]	M. R. Hall	156	752	1.40	2.00	1,049
August 18 [b]	do	295	748	1.42	2.03	1,064
September 27 [b]	W. E. Hall	290	552	.85	1.37	470
October 15 [b]	do	285	510	.78	1.26	397
November 8 [b]	do	291	588	.98	1.50	574

[a] At Rome, Second Avenue Bridge.
[b] At Freeman's ferry, 5 miles above Rome.

Mean daily gage height, in feet, of Etowah River near Rome, Ga., for 1904.

	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	1.75	1.30	1.30	1.55	17.....	2.10	1.40	1.30	1.60	1.70
.....	.....	1.75	1.30	1.30	1.55	18.....	2.05	1.40	[a]1.30	1.55	1.75
.....	.....	1.70	1.25	1.50	1.60	19.....	2.10	1.40	1.25	1.55	1.70
.....	.....	1.70	1.35	1.40	1.70	20.....	1.85	1.40	1.35	1.55	1.70
.....	.....	1.75	1.30	1.50	1.80	21.....	1.80	1.40	1.30	1.55	1.65
.....	.....	1.80	1.30	1.60	3.10	22.....	2.50	1.40	1.30	1.55	1.60
.....	.....	1.70	1.30	1.55	3.00	23.....	1.70	1.40	1.30	1.60	1.60
.....	.....	1.65	1.30	1.55	2.20	24.....	3.40	1.40	1.20	1.90	1.60
.....	.....	1.60	1.25	1.55	1.90	25.....	[a]3.00	1.35	1.25	1.75	1.60
.....	.....	[a]1.60	1.20	1.55	1.80	26.....	2.10	1.35	1.30	1.60	1.70
.....	.....	1.60	1.35	1.40	1.90	27.....	[a]2.50	1.35	1.30	1.60	1.70
.....	.....	1.60	1.35	1.40	1.95	28.....	2.80	1.35	1.30	1.55	3.00
.....	.....	1.50	1.40	[a]1.50	1.80	29.....	2.30	1.35	1.30	1.55	3.40
.....	.....	1.50	1.30	1.60	1.70	30.....	1.90	1.35	1.30	1.55	2.50
.....	.....	1.50	1.30	1.75	1.70	31.....	1.90	.....	1.30	.....	2.00
.....	.....	1.45	1.30	1.60	1.65						

[a] Interpolated (no record).

table for Etowah River near Rome, Ga., from August 17 to December 31, 1904.

t.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
)	360	1.80	830	2.40	1,500	3.00	2,320
)	425	1.90	930	2.50	1,625	3.10	2,470
)	495	2.00	1,035	2.60	1,755	3.20	2,625
)	570	2.10	1,145	2.70	1,890	3.30	2,785
)	650	2.20	1,260	2.80	2,030	3.40	2,950
)	735	2.30	1,380	2.90	2,175		

above table is based upon 5 discharge measurements made during 1904 and 1 February, 1905. It is well defined.

Estimated monthly discharge of Etowah River near Rome, Ga., for 1904.

[Drainage area, 1,854 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
(17–31).....	2,950	735	1,384	0.746	0.416
ber.....	830	460	588	.317	.354
.....	495	360	423	.228	.263
ber.....	930	425	614	.331	.369
ser.....	2,950	610	1,027	.554	.639

COOSA RIVER AT RIVERSIDE, ALA.

This station was established September 25, 1896, by M. R. Hall. It is located at the Southern Railway bridge, Riverside, Ala., about 4 miles below Lock No. 4. The 24-inch boxed chain gage is fastened to the downstream guard rail at a point 570 feet from the initial point for soundings. The length of the chain from the marker to the end of the weight is 35.02 feet. The gage is read once each day by S. T. Waits. Discharge measurements are made from the railway bridge to which the gage is attached. The initial point for soundings is the water face of the abutment on the left bank, downstream side. Distances are marked on the guard rail with white paint. The channel is straight above the station for about 400 feet and below for about 3,000 feet. The current is swift, but is broken by a ledge of rock 300 feet above the bridge. The channel is 614 feet between bridge abutments and is broken by four piers. The width at ordinary stages is about 575 feet. Both banks are high; the left bank is liable to overflow, but all water passes beneath the bridge. The bed of the stream is rocky and permanent and not very rough.

Bench mark No. 1 is the capstone on the circular pier of the turn span, the elevation of which is 26.80 feet above gage datum. Bench mark No. 2 is a copper plug set in solid rock on the right bank, about 100 feet above the bridge. Its elevation is 11.95 feet above gage datum. The observer is paid by the Alabama Geological Survey.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Coosa River at Riverside, Ala., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
March 16	J. M. Giles	570	8,977	4.46	10.75	40,070
April 11	do	566	7,680	4.00	8.80	30,710
June 20	do	500	4,120	1.79	2.87	7,374
July 22	do	492	3,871	1.43	2.30	5,549
August 26	do	429	3,234	1.24	1.64	4,001
October 1	do	405	2,865	.94	1.05	2,687
November 13	do	430	3,113	1.01	1.37	3,136
1904.						
January 19	J. M. Giles	446	3,444	1.16	1.88	3,999
February 11	M. R. and W. E. Hall.	528	4,785	2.27	4.10	10,880
May 26	J. M. Giles	409	2,895	.94	1.25	2,714
June 27	do	407	2,861	.90	1.15	2,582
August 23	do	497	3,268	.97	1.45	3,174
September 20	A. T. Mitchelson	488	2,947	.57	.60	1,681
September 21	do	485	2,783	.56	.53	1,557
November 2	J. M. Giles	433	2,625	.48	.38	1,250

Mean daily gage height, in feet, of Coosa River at Riverside, Ala., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.35	2.10	2.90	4.00	2.30	2.30	2.60	1.15	1.20	0.50	0.35	0.70
.....	1.30	2.05	2.60	3.60	2.15	2.70	2.55	1.35	1.20	.50	.40	.80
.....	1.30	2.05	2.45	3.40	2.10	2.80	2.30	1.50	1.20	.50	.45	.80
.....	1.25	2.00	2.60	3.10	1.90	3.00	2.15	2.60	1.10	.50	.60	1.00
.....	1.25	2.00	2.85	3.00	1.90	2.55	1.90	2.80	1.00	.50	.65	1.70
.....	1.20	1.90	3.05	2.75	1.80	2.05	1.45	3.00	1.00	.55	.70	2.75
.....	1.20	1.95	3.90	2.70	1.75	1.70	2.10	3.80	1.00	.60	.75	3.20
.....	1.20	2.75	4.30	3.20	1.80	1.65	2.15	4.20	1.00	.60	.75	3.75
.....	1.20	3.35	4.80	3.80	1.90	1.65	1.55	3.80	1.00	.55	.75	3.50
.....	1.20	3.55	5.20	5.10	1.80	1.95	1.40	4.35	1.00	.50	.70	3.20
.....	1.25	4.05	4.80	5.20	1.80	2.00	1.40	6.25	.95	.50	.70	3.00
.....	1.30	3.95	4.30	4.90	2.60	1.70	1.40	5.40	.95	.50	.70	2.85
.....	1.30	3.70	4.30	4.20	2.20	1.50	1.40	4.15	.85	.50	.65	2.60
.....	1.30	3.35	4.30	3.50	2.10	1.30	1.25	3.20	.80	.45	.55	2.40
.....	1.40	3.05	4.05	3.00	2.00	1.15	1.25	2.70	.70	.40	.55	2.00
.....	1.45	2.90	4.00	2.80	1.70	1.15	1.25	2.55	.60	.40	.60	1.60
.....	1.50	2.30	3.90	2.70	1.60	1.05	1.30	2.30	.60	.40	.70	1.30
.....	1.80	2.35	3.70	2.60	1.50	1.05	1.30	2.15	.60	.40	.70	1.25
.....	1.90	2.50	3.80	2.40	1.55	1.05	1.40	1.95	.60	.40	.65	1.20
.....	2.10	2.90	3.80	2.40	1.50	1.00	1.65	1.75	.60	.35	.65	1.10
.....	2.25	3.25	3.50	2.35	1.40	1.00	1.50	1.65	.75	.35	.65	1.10
.....	2.50	3.80	3.20	2.25	1.35	1.00	1.30	1.50	.90	.35	.70	1.10
.....	4.45	4.90	3.30	2.20	1.30	1.00	1.10	1.45	.90	.35	.75	1.10
.....	5.10	5.45	5.30	2.20	1.30	1.40	1.10	1.35	.90	.35	.75	1.10
.....	5.00	6.05	6.10	2.15	1.20	1.50	1.10	1.30	.75	.35	.75	1.10
.....	4.30	5.80	6.85	2.15	1.20	1.40	1.15	1.25	.60	.35	.75	1.10
.....	4.00	4.80	6.20	2.15	1.15	1.20	1.20	1.25	.60	.35	.75	1.70
.....	3.70	3.80	5.90	2.40	1.15	1.00	1.20	2.00	.55	.35	.80	2.90
.....	3.30	3.30	5.50	2.50	1.20	1.50	1.20	1.90	.55	.35	.80	3.75
.....	2.55	.....	4.90	2.60	1.20	2.25	1.10	1.55	.55	.35	.80	5.00
.....	2.30	.....	4.40	.....	1.80	.....	1.15	1.40	.....	.35	.....	5.20

Rating table for Coosa River at Riverside, Ala., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
.30	1,150	1.40	3,010	2.40	5,425	3.80	9,780
.40	1,300	1.50	3,215	2.50	5,695	4.00	10,480
.50	1,450	1.60	3,430	2.60	5,970	4.20	11,200
.60	1,605	1.70	3,655	2.70	6,250	4.40	11,920
.70	1,760	1.80	3,890	2.80	6,540	4.60	12,640
.80	1,920	1.90	4,130	2.90	6,835	4.80	13,360
.90	2,085	2.00	4,380	3.00	7,135	5.00	14,080
1.00	2,255	2.10	4,635	3.20	7,750	5.50	15,900
1.10	2,435	2.20	4,895	3.40	8,400	6.00	17,750
1.20	2,620	2.30	5,160	3.60	9,080	6.50	19,600
1.30	2,810						

The preceding table is based upon seven discharge measurements made during 1904 and several older measurements. It is well defined between gage heights 0.4 feet and 4 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Coosa River at Riverside, Ala., for 1904.

[Drainage area, 7,065 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	14,440	2,620	5,228	0.740	0.853
February	17,940	4,130	8,391	1.19	1.28
March	20,900	5,560	11,370	1.61	1.86
April	14,800	4,765	7,462	1.06	1.18
May	5,970	2,527	3,676	.520	.600
June	7,135	2,255	3,598	.509	.568
July	5,970	2,435	3,314	.469	.541
August	18,680	2,527	6,118	.866	.998
September	2,620	1,528	1,987	.281	.314
October	1,605	1,225	1,351	.192	.221
November	1,920	1,225	1,713	.242	.270
December	14,800	1,760	5,127	.726	.837
The year	20,900	1,225	4,945	.700	9.52

OOSTANAULA RIVER AT RESACA, GA.

This station was maintained by the United States Geological Survey from August 1, 1896, to April 30, 1899. During this time it was also maintained by the United States Weather Bureau as a half-year station. The gage height records are now taken for the Weather Bureau during the entire year by their local observer, G. A. Norton. The station is located at the bridge of the Western and Atlantic Railway, which is in the town of Resaca, 800 feet south of the depot. A heavy timber gage is attached vertically to the downstream side of the center pier. Discharge measurements are made from the downstream side of the iron through bridge to which the gage is attached. The bridge consists of three spans of 120 feet each, and 480 feet of trestle approach at the left bank. The left bank span of the bridge is entirely outside of the river, except at high water. Measurements are also made from a boat at the ferry about 200 feet above the bridge, where the section is somewhat better. The initial point for soundings is the end of the bridge at the right bank, downstream side. The channel is slightly curved, the same curve extending about 300 feet above and below the bridge. The current is moderate, becoming rather sluggish at low water. The right bank is rock at the edge of water, and has solid stone abutment and railroad embankment, which is above high-water level. The left bank

low, cultivated, and overflows during high water 480 feet to the end :.the trestle. The bed of the stream is composed of rock near the ght bank, but other parts appear to be sandy. To the left of the pier is nearly filled up with logs and brush. There is one channel broken r one pier at ordinary water. Bench mark No. 1 is the top of the wnstream end of the second crossbeam from the right bank. Its evation is 28.94 feet above the datum of the gage. Bench mark No. established March 14, 1905, is a cross mark on the top of the lime-one bowlder on the north side of the river, about 130 feet from the id of the railroad bridge and 40 feet west of the railroad track. Its evation is 34.23 feet above the datum of the gage.

COOSAWATTEE RIVER AT CARTERS, GA.

This river is formed by the junction of Ellijay and Cartecay rivers : Ellijay, Ga., and flows in a southwesterly direction, joining the onasauga to form the Oostanaula. Its drainage area is for the most art mountainous and covered with forest growth. This station was stablished August 15, 1896, by M. R. Hall, at the iron highway ridge at Carters, Murray County, Ga., about 20 miles northeast of alhoun, the most convenient railroad station. Carters is at the head f navigation, small boats running to Rome, Ga., and the Coosa River elow. It is at the foot of the great shoals made by this stream in itting through the Cohutta Mountains.

A standard chain gage is attached to the downstream side of the ridge in the third panel from the right bank. The original length of ie chain before it was boxed was 37.08 feet from the end of the eight to the marker. On March 17, 1905, the gage was replaced by boxed gage of the 24-inch iron top type, and the length of the chain as made 36.57 feet from the end of the weight to the marker, the itum remaining the same. The observer is R. P. Messer, a merchant ; Carters, Ga., who is paid by the Georgia Geological Survey.

Discharge measurements are made from the single-span highway ridge and its approaches. The initial point for soundings is land de of the pier on the right bank. The channel is curved for 1,000 et above and 500 feet below the station. The current is swift and roken. Both banks are high, but overflow at flood stages. The bed f the stream is of gravel, and is not liable to change.

Bench mark No. 1 is the top of the cylindrical iron pier at the right ink, downstream side. Its elevation is 30.35 feet above gage datum. ench mark No. 2, established March 17, 1905, is a stone post set ito the ground on the north side of the river about 300 feet from the id of the iron bridge and on the west side of the road leading toward arter's mill. The elevation of the top of the post is 22.15 feet above he datum of the gage.

The observations at this station during 1904 have been made under he direction of M. R. *Hall*, district hydrographer.

Discharge measurements of Coosawattee River at Carters, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
1903.						
March 18	O. P. Hall		518	3.06	3.56	1,588
July 22	do		580	2.53	2.35	963
September 8	do		265	1.67	1.22	444
September 8	M. R. Hall		265	1.72	1.22	456
October 16	O. P. Hall		242	1.55	1.07	374
December 31	do		247	1.68	1.26	416
1904.						
March 15	O. P. Hall	118	418	2.50	2.60	1,045
May 26	do	107	252	1.70	1.30	427
June 25	do	107	220	1.46	.99	322
August 23	do	104	203	1.54	.85	312
September 27	do	83	181	1.12	.50	202
December 21	do	102	191	1.44	.82	275
December 21	M. R. Hall	100	186	1.26	.73	235

Mean daily gage height, in feet, of Coosawattee River at Carters, Ga., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.20	1.50	1.70	2.20	1.70	2.00	1.10	5.00	0.80	0.50	0.40	2.00
2	1.10	1.50	1.70	2.20	1.70	1.80	1.00	2.00	.70	.50	.40	2.20
3	1.40	1.50	1.70	2.10	1.70	1.50	1.00	1.50	.70	.50	.40	1.80
4	1.10	1.50	3.50	2.00	2.00	1.30	1.00	1.30	.70	.45	.70	1.60
5	1.10	1.40	3.75	1.90	1.80	1.20	1.00	1.60	.90	.45	.60	1.80
6	1.10	1.30	3.00	1.90	1.70	3.10	1.40	1.20	.80	.45	.60	1.60
7	1.10	1.40	3.00	1.90	1.70	3.00	1.30	1.10	.70	.45	.50	1.40
8	1.10	2.80	2.50	4.00	4.45	2.00	1.80	1.60	.70	.45	.50	1.30
9	1.10	2.60	2.20	3.00	3.00	1.80	1.50	2.00	.60	.40	.50	1.20
10	1.10	1.80	2.10	2.50	2.00	1.60	1.20	1.50	.60	.40	.50	1.10
11	1.30	1.60	2.00	2.30	1.80	1.30	1.00	1.40	.60	.40	.40	1.00
12	1.30	1.50	1.90	2.20	1.70	1.30	2.05	1.30	.60	.40	.40	1.00
13	1.30	1.50	1.80	2.00	1.70	1.20	1.70	1.10	.50	.40	.40	1.00
14	1.30	1.40	4.80	1.90	1.70	1.20	1.20	1.00	.50	.40	.40	.90
15	1.20	1.70	2.80	1.90	1.60	1.20	1.00	1.00	.70	.40	.40	.90
16	1.30	1.70	2.20	1.90	1.60	1.20	1.00	1.00	.60	.40	.40	.90
17	2.80	1.60	2.10	1.80	1.60	1.10	1.80	1.00	.60	.40	.40	.85
18	1.90	1.60	2.00	1.80	1.60	1.10	1.30	1.00	.50	.40	.40	.85
19	1.50	3.40	1.80	1.80	1.50	1.10	1.00	.90	.50	.40	.40	.85
20	1.40	3.00	1.80	1.80	1.50	1.00	1.00	.90	.40	.40	.40	.85
21	1.40	2.30	1.80	1.80	1.50	3.00	.90	.90	.40	.40	.40	.85
22	4.35	4.80	2.00	1.80	1.50	2.00	1.80	.80	.40	.40	.50	.85
23	3.00	3.50	5.20	1.80	1.40	1.50	1.50	.80	.50	.40	.60	.80
24	2.30	2.40	3.80	1.70	1.40	1.20	1.00	.80	.50	.40	.60	.80
25	2.00	2.20	2.90	1.70	1.30	1.00	1.00	.90	.50	.40	.60	1.00
26	1.70	2.10	2.80	4.00	1.30	1.00	1.00	1.00	.45	.40	.60	1.30
27	1.60	2.00	2.80	2.50	1.30	1.00	.90	.90	.50	.40	.60	3.90
28	1.50	1.80	2.60	2.00	1.20	1.20	1.10	1.00	.50	.40	.50	4.00
29	1.50	1.80	2.50	1.80	1.20	1.20	1.00	.90	.50	.40	.50	2.00
30	1.50	.....	2.40	1.70	1.20	1.80	1.00	.90	.50	.40	1.80	1.80
31	1.50	.....	2.30	.....	3.70	.....	.90	.80	.....	.40	.....	1.80

ting table for Coosawattee River at Carters, Ga., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	184	1.80	650	4.20	2,000	9.50	5,790
.50	202	1.90	698	4.40	2,130	10.00	6,150
.60	222	2.00	747	4.60	2,270	11.00	6,870
.70	244	2.20	848	4.80	2,410	12.00	7,590
.80	269	2.40	952	5.00	2,550	13.00	8,310
.90	296	2.60	1,058	5.50	2,910	14.00	9,030
1.00	326	2.80	1,166	6.00	3,270	15.00	9,750
1.10	358	3.00	1,275	6.50	3,630	16.00	10,470
1.20	393	3.20	1,385	7.00	3,990	17.00	11,190
1.30	430	3.40	1,500	7.50	4,350	18.00	11,910
1.40	470	3.60	1,620	8.00	4,710	19.00	12,630
1.50	512	3.80	1,740	8.50	5,070	20.00	13,350
1.60	557	4.00	1,870	9.00	5,430	21.00	14,070
1.70	603						

The above table is based upon seventeen discharge measurements made during 02, 1903, and 1904. It is well defined between gage heights 0.5 foot and 4.5 feet. ie table has been extended beyond these limits to gage height 5.5. Above gage ight 4.8 feet the rating curve is a tangent, the difference being 73 per tenth.

Estimated monthly discharge of Coosawattee River at Carters, Ga., for 1904.

[Drainage area, 531 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
nuary	2,097	358	575	1.08	1.24
ebruary	2,410	430	791	1.49	1.61
arch	2,694	603	1,063	2.00	2.31
pril	1,870	603	823	1.55	1.73
ay	2,165	393	659	1.24	1.43
ine	1,330	326	549	1.03	1.15
ily	772	296	408	.768	.885
ugust	2,550	269	453	.853	.983
eptember	296	184	220	.414	.462
ctober	202	184	187	.352	.406
ovember	650	184	215	.405	.452
ecember	1,870	269	524	.987	1.14
The year	2,694	184	539	1.01	13.80

CARTECAY RIVER NEAR CARTECAY, GA.

This station was established June 27, 1904, by M. R. Hall. It is located at the Cartecay Bridge on the public road 6 miles southeast (upstream) from Ellijay, Ga., and 1½ miles northwest from Cartecay, Ga. Turkey Creek enters from the south side and Owltown Creek from the north side between this point and Ellijay. There is probably no considerable interference from dams above the station. The gage is a vertical 10-foot timber, graduated to feet and tenths, fastened to a 2-inch by 4-inch oak scantling, which is spiked to the sill and downstream post of trestle bent at the right bank. The gage is read once each day by S. A. Burrell, who is paid by the Georgia Geological Survey. Discharge measurements are made from the downstream side of the single 60-foot span wooden bridge to which the gage is attached. The bridge has an approach on the right bank of 24 feet and on the left bank of 26 feet. The floor is about 16 feet above low water. The initial point for soundings is the edge of the abutment on the right bank, downstream side. The channel is straight for about 500 feet above and below the station. The current is swift. Both banks are high, but are subject to overflow. The bed of the stream is composed of rock and is permanent, the water flowing in one channel. The bench mark is the top of the downstream end of the first floor beam from the right bank, marked by nails and white paint. Its elevation is 16.50 feet above the zero of the gage.

Discharge measurements of Cartecay River near Cartecay, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 9	O. P. Hall	55	78	2.26	1.30	176
June 27	do	53	50	1.72	.90	86
August 31	do	53	50	1.88	.85	94
October 12	do	48	38	1.84	.65	70
December 13	M. R. Hall	52	46	1.70	.80	78

an daily gage height, in feet, of Cartecay River near Cartecay, Ga., for 1904.

	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
....	1.10	1.10	0.80	0.90	0.75	1.15	17	1.30	1.30	1.30	0.70	0.75	0.90
....	1.10	1.20	.85	(a)	.80	.90	18	1.50	1.25	2.10	.70	.80	.85
....	1.30	2.40	1.20	(a)	.80	1.10	19	3.05	3.55	.90	.75	.85	.80
....	1.50	1.65	1.10	(a)	.85	1.00	20	3.05	2.15	.90	.60	.90	.75
....	1.70	2.30	.90	(a)	.90	1.50	21	2.20	1.90	.85	.65	.80	.75
....	1.75	2.85	.90	(a)	.80	1.20	22	1.70	1.70	.80	.75	.95	.70
....	3.30	1.90	.85	(a)	.85	1.20	23	1.60	1.30	2.30	.75	.95	.70
....	2.20	1.70	.80	(a)	.90	1.10	24	2.20	1.25	2.15	.75	.90	.90
....	1.40	1.50	1.40	(a)	.95	1.00	25	1.95	3.35	.95	.65	.85	1.10
....	1.30	1.45	.85	(a)	.90	1.00	26	1.30	2.70	1.90	.60	.80	.90
....	1.35	1.40	.80	(a)	1.20	.90	27	1.25	1.60	.80	.65	.80	.90
....	3.50	2.65	.80	.65	1.30	.90	28	1.70	1.15	.80	.70	.85	2.50
....	5.40	2.10	.85	(a)	1.10	.80	29	1.25	1.10	1.20	.75	.85	2.20
....	2.30	1.70	.80	(a)	.95	.80	30	1.10	.90	.90	.70	1.30	1.20
....	2.10	1.50	.75	(a)	.90	.85	31	.....	.85	.....	.70	.....	.90
....	1.30	1.35	.80	(a)	.80	.85							

a Missing.

ELLIJAY RIVER NEAR ELLIJAY, GA.

s station was established June 28, 1904, by M. R. Hall for the ›se of making a series of miscellaneous measurements. It is d at a wagon bridge about one-half mile east of Ellijay, Ga., and the same distance above the junction of Ellijay and Cartecay . A section of gage staff, graduated by feet and tenths from 2 eet, is nailed to the downstream vertical post at the right bank, bench mark established for reference. Regular gage readings ot maintained. Discharge measurements are made from the wooden wagon bridge, having two 40-foot spans and 50-foot aches on each bank. The initial point for soundings is the end › bridge at right bank, on the downstream side. Both banks ›raight for about 500 feet above and below the station. The bank is about 12 feet high and the left bank is about 10 feet Both banks are bordered by fields and are subject to overflow. is one channel broken by one wooden pier. The bed of the n is composed of rock, partly sloping, and the current ranges very swift above the station to sluggish below. The bench is a small nail and white paint mark in downstream vertical post ht bank. Its elevation is 7.00 feet above the gage datum.

Discharge measurements of Ellijay River near Ellijay, Ga., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
1903.						
December 9	O. P. Hall	65	56	1.36	.....	76
1904.						
May 10	O. P. Hall	74	90	1.71	1.80	154
June 28	do	66	61	1.54	1.35	94
August 30	do	68	56	1.22	1.22	68
October 12	do	56	41	1.03	1.07	42
December 14	M. R. Hall	66	50	1.32	1.20	66

MOUNTAINTOWN CREEK NEAR ELLIJAY, GA.

This station was established as a bench-mark station May 10, 1904, by O. P. Hall. It is located at the covered bridge known as Charles Bridge, about 4 miles west of Ellijay, Ga., and about the same distance above the mouth of the creek. The bridge consists of a single span of 54 feet, with short trestle approaches at either end. Discharge measurements are made from the bridge, the meter being lowered through holes in the floor, or from a foot log a half mile below the bridge. The initial point for soundings is the end of the trestle approach at the right bank. The channel is straight for about 500 feet above and 100 feet below the station and the current is swift. Both banks are high and not liable to overflow. The bed of the stream is rocky. The water is shallow and swift at the bridge, the better section being at the foot log below the bridge. The bench mark is a nail driven into the vertical post of the main bent under the right end of the bridge, 6 feet above the top of the mud sill of the bent. Its elevation is 7.00 feet above datum.

Discharge measurements of Mountaintown Creek near Ellijay, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 10	O. P. Hall	60	51	3.08	1.17	157
August 31	do	52	34	2.32	.85	79
October 12	do	26	44	.70	.75	31

TALKING ROCK CREEK NEAR CARTERS, GA.

This station was established as a bench-mark station May 26, 1904, by O. P. Hall, though numerous measurements of the creek have pre-

viously been made by M. R. Hall and O. P. Hall in connection with measurements of the Coosawattee River station. It is located about 3 miles above the mouth of Talking Rock Creek and about the same distance east of Carters, Ga. Discharge measurements are made from a boat just above R. L. Hill's boat landing or by wading at a shoal a short distance below. Both banks are high and will probably not overflow. There is one channel at all stages. The section is a good one. The bench mark is a nail in a large elm tree on the left bank at R. L. Hill's boat landing. Its elevation is 7.50 feet above datum.

Discharge measurements of Talking Rock Creek near Carters, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 26	O. P. Hall	59	103	0.48	1.24	49
June 25	do	58	97	.35	1.08	34
August 23	do	22	18	2.22	1.07	40

CHOCCOLOCCO CREEK NEAR JENIFER, ALA.

The gage at this station was established August 20, 1902, by J. M. Giles. Measurements were first made by J. R. Hall in 1900. It is located at the Louisville and Nashville Railroad bridge, 1¼ miles north of Jenifer, Ala. There are small shoals both above and below the bridge. The gage consists of a vertical 1 by 4 inch pine plank, nailed to a 3 by 8 inch pine timber which is spiked to a birch tree 20 feet upstream from the bridge on the left bank. It reads from 0.30 to 10 feet. The observer is W. J. Tolbert, who is paid by the Alabama Geological Survey. Discharge measurements are made from the single-span bridge and its trestle approach on the right bank. The initial point for soundings is the end of the bridge on the left bank, and distances are marked with white paint on the upstream guard rail. The channel is straight for 1,500 feet above and below the station and has a width between abutments of 145 feet and 100 feet at low water. The right bank overflows at a gage reading of about 6 feet. The left bank is high and will not overflow except under the bridge. The bed is rocky and not likely to change.

Bench mark No. 1 is the top of a crossbeam at a point 50 feet from the initial point for soundings. Its elevation is 23.00 feet above the zero of the gage. Bench mark No. 2 is a copper plug in the upstream wing of the left abutment; its elevation is 14.19 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Choccolocco Creek near Jenifer, Ala., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discha
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second*
July 23	J. M. Giles	96	158	1.17	2.25	
July 23	do	96	157	1.14	2.25	
August 20	do	98	158	1.16	2.26	
August 25	do	99	174	.84	2.12	
October 2	do	85	115	.78	1.82	
November 14	do	96	125	1.04	2.08	
1904.						
January 20	J. M. Giles	95	144	.97	2.09	
February 12	W. E. Hall	105	228	1.71	2.82	
February 12	M. R. Hall	105	219	1.75	2.85	
February 20	Murphy and Giles	100	220	1.74	2.72	
March 10	W. E. Hall	100	183	1.29	2.40	
May 27	J. M. Giles	85	115	.72	1.80	
July 20	W. E. Hall	85	128	.94	1.99	
August 24	J. M. Giles	90	134	.92	1.94	
August 30	do	90	135	.92	1.95	
September 22	A. T. Michelson	90	116	.79	1.71	
October 12	J. M. Giles	86	128	.81	1.83	
October 12	do	86	127	.78	1.80	
November 26	do	86	128	.73	1.75	
November 26	do	86	129	.79	1.86	

Mean daily gage height, in feet, of Choccolocco Creek near Jenifer, Ala., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	2.10	2.30	2.10	2.10	2.20	2.10	1.90	1.80	1.65	1.40	1.50
2	1.90	2.10	2.30	2.10	2.00	2.20	2.00	2.00	1.80	1.70	1.40	1.60
3	1.90	2.10	2.30	2.15	2.00	2.10	2.20	2.00	1.80	1.70	1.60	1.70
4	2.00	2.10	2.20	2.10	2.00	1.90	1.90	2.00	1.80	1.60	1.70	1.70
5	1.90	2.10	2.20	2.10	2.00	1.85	1.80	2.80	2.10	1.60	1.70	1.80
6	1.90	2.10	2.20	2.15	2.00	1.85	1.80	2.20	2.00	1.60	1.80	2.00
7	1.90	2.30	2.60	2.10	2.00	1.80	1.80	3.50	1.90	1.60	1.70	2.20
8	1.90	3.30	2.60	2.60	2.00	1.80	1.80	3.60	1.80	1.50	1.70	1.90
9	1.90	3.40	2.50	2.80	2.15	1.90	1.90	3.40	1.75	1.60	1.65	1.85
10	1.90	2.80	2.40	2.50	2.15	1.80	2.00	2.70	1.75	1.50	1.60	1.80
11	1.90	2.90	2.30	2.40	2.00	1.80	2.10	2.70	1.80	1.50	1.50	1.80
12	2.00	2.80	2.30	2.30	1.90	1.80	1.90	4.00	1.80	1.50	1.40	1.80
13	2.00	2.60	2.30	2.20	1.90	1.80	1.80	3.00	1.80	1.50	1.70	1.80
14	2.00	2.50	3.00	2.20	1.90	1.80	1.80	2.50	1.70	1.50	1.70	1.70
15	1.90	2.40	3.00	2.20	2.00	1.75	1.80	2.30	1.70	1.50	1.60	1.70
16	1.90	2.30	2.85	2.10	1.90	1.75	1.80	2.40	1.70	1.50	1.60	1.70
17	2.20	2.30	2.60	2.10	1.80	1.75	1.80	2.20	1.65	1.60	1.60	1.70
18	2.30	2.20	2.50	2.10	1.80	1.70	1.80	2.20	1.70	1.50	1.60	1.90
19	2.20	2.20	2.40	2.10	1.80	1.70	1.70	2.00	1.70	1.50	1.60	1.75
20	2.00	2.60	2.35	2.10	1.80	1.70	2.00	2.00	1.65	1.50	1.60	1.70
21	1.90	2.80	2.30	2.10	1.80	1.75	1.80	1.95	1.70	1.50	1.70	1.60
22	2.40	2.80	2.30	2.10	1.80	1.80	1.75	1.95	1.65	1.50	1.70	1.60
23	3.40	3.30	2.30	2.00	1.80	1.75	1.80	1.95	2.10	1.50	1.80	1.60
24	2.80	3.20	2.25	2.00	1.75	1.80	1.75	1.90	2.20	1.40	2.00	1.60
25	2.40	2.80	2.20	2.00	1.80	2.00	1.70	1.90	2.00	1.40	1.80	1.70
26	2.20	2.60	2.20	2.05	1.80	1.90	1.65	1.90	1.80	1.40	1.75	1.80
27	2.10	2.50	2.20	2.20	1.75	1.80	1.70	2.75	1.80	1.40	1.70	1.80
28	2.10	2.50	2.25	2.25	1.80	1.80	1.70	2.10	1.70	1.40	1.70	2.70
29	2.10	2.40	2.20	2.15	1.80	2.50	1.70	2.00	1.70	1.40	1.70	2.60
30	2.10	.....	2.10	2.00	1.80	2.60	2.25	1.95	1.65	1.50	1.60	2.10
31	2.10	.....	2.15	.....	2.00	.....	1.90	1.95	.....	1.50	.....	2.00

ating table for Choccolocco Creek near Jenifer, Ala., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.40	62	1.90	113	2.40	230	2.80	383
1.50	68	2.00	130	2.50	263	2.90	430
1.60	76	2.10	150	2.60	300	3.00	480
1.70	86	2.20	173	2.70	340	3.10	530
1.80	98	2.30	200				

The above table is based upon twenty discharge measurements made during 1903–4. t is well defined between gage heights 1.70 feet and 2.80 feet. Estimates above 3.1 et are based upon a tangent with a difference of 55 per tenth.

Estimated monthly discharge of Choccolocco Creek near Jenifer, Ala., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	695	113	165
February	695	150	307
March	480	150	231
April	383	130	173
May	161	92	116
June	300	86	118
July	186	81	109
August	1,025	113	270
September	173	81	101
October	86	62	70.0
November	130	62	82.7
December	340	68	112
The year	1,025	62	155

TALLADEGA CREEK AT NOTTINGHAM, ALA.

This station was established August 16, 1900, by J. R. Hall. It is located on the Southern Railway bridge, a fourth of a mile from the depot at Nottingham, Ala., and 1 mile north of Alpine, Ala. The gage, which is graduated to feet and tenths and is 20 feet long, is fastened vertically to a tree on the right bank, about 50 feet upstream from the bridge. The observer is R. M. McClatchy, station agent at Nottingham, who is paid by the Alabama Geological Survey.

The initial point for soundings is end of iron bridge, upstream, right bank. The channel is straight for about 500 feet above and below the station and the current is sluggish at low stages. The right bank is high and does not overflow; the left bank is lower than the right and overflows at high stages; but all water passes beneath the bridge. The bed of the stream is of sand and silt and is fairly constant.

Bench mark No. 1 is a nail on the upstream corner of the right bank abutment; its elevation is 14.25 feet above the zero of the gage. Bench mark No. 2 is a copper plug set in the limestone rock at a large spring 335 feet above the railway track on the right bank; its elevation is 6.28 feet above the zero of the gage. The station was discontinued on December 31, 1904.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

rge measurements of Talladega Creek at Nottingham, Ala., in 1903 and 1904.

te.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
)3.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
.....	J. M. Giles.....	.....	285	0.85	2.05	243
.....	.....do	.....	267	.42	1.37	111
)0.....	.....do	.....	254	.46	1.30	116
2.....	.....do	.....	228	.25	1.00	57
er 14...	.....do	.....	243	.33	1.21	80
4.						
20.....	J. M. Giles.....	70	259	.41	1.30	105
21.....	.....do	70	257	.39	1.27	100
y 20....	Giles and Murphy.	70	295	.79	2.02	233
0.....	W. E. Hall.....	70	264	.55	1.51	145
.....	J. M. Giles.....	55	188	.23	1.00	44
.....	.....do	27	48	1.04	1.00	50
4.....	.....do	69	225	.38	1.15	86
er 22 ..	A. T. Michelson	70	222	.32	1.03	72
er 13...	J. M. Giles.....	66	214	.24	1.05	52
er 13 [a]	.....do	32	56	.88	1.05	49

[a] Wagon bridge below mill, one-half mile above railroad bridge.

daily gage height, in feet, of Talladega Creek at Nottingham, Ala., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.10	1.30	1.60	1.30	1.15	1.20	1.70	1.75	1.00	1.00	0.90	1.10
.....	1.10	1.60	1.50	1.30	1.10	1.40	1.20	2.45	1.00	1.00	1.00	1.10
.....	1.10	1.70	1.50	1.35	1.10	1.20	1.20	1.35	1.00	1.00	1.10	1.10
.....	1.10	1.70	1.50	1.35	1.10	1.10	1.10	2.10	1.05	1.00	1.10	1.05
.....	1.10	2.60	1.40	1.35	1.10	1.00	1.10	5.60	1.00	1.00	1.10	1.20
.....	1.10	1.60	1.40	1.40	1.00	1.00	1.10	3.20	1.00	1.10	1.10	1.20
.....	1.10	2.70	2.00	1.40	1.00	1.00	1.05	2.65	1.00	1.10	1.10	1.15
.....	1.30	3.80	1.80	1.50	1.10	1.00	1.00	5.70	1.00	1.00	1.05	1.10
.....	1.20	2.40	1.65	1.40	1.00	1.00	1.00	4.10	1.00	1.00	1.05	1.10
.....	1.50	2.40	1.55	1.35	1.00	1.00	1.10	3.00	1.00	1.00	1.05	1.10
.....	1.40	3.20	1.50	1.35	1.00	1.00	1.00	3.10	1.00	1.00	1.05	1.05
.....	1.30	2.40	1.50	1.40	1.00	1.00	1.80	2.40	1.00	1.00	1.05	1.05
.....	1.30	2.10	1.60	1.35	1.00	1.00	1.80	2.00	1.00	1.00	1.10	1.05
.....	1.30	1.80	2.50	1.30	1.00	1.00	1.25	1.70	1.00	1.00	1.20	1.05
.....	1.30	1.70	2.20	1.30	1.00	1.00	1.10	1.65	1.00	1.00	1.20	1.05
.....	1.30	1.70	1.80	1.30	1.00	.90	1.05	2.10	.95	1.00	1.20	1.05
.....	2.50	1.60	1.65	1.30	1.00	.85	1.00	1.55	.95	1.00	1.15	1.10
.....	1.80	1.60	1.65	1.30	1.00	.80	1.00	1.40	.95	1.00	1.15	1.00
.....	1.60	1.80	1.55	1.30	1.00	1.00	1.00	1.35	.95	1.00	1.10	1.00
.....	1.40	2.10	1.50	1.30	1.00	1.00	1.00	1.30	.95	1.00	1.05	1.00
.....	1.30	1.80	1.50	1.30	1.00	.90	1.00	1.20	1.00	1.00	1.05	1.00
.....	4.00	2.00	1.45	1.30	1.00	.90	1.00	1.15	1.05	1.00	1.20	1.00
.....	3.20	2.40	1.40	1.30	1.00	.90	1.00	1.10	1.40	1.00	1.45	1.00
.....	2.00	2.10	1.40	1.30	1.00	.85	1.10	1.00	1.20	1.00	1.30	1.00
.....	1.70	1.90	1.40	1.25	1.00	.85	1.20	1.00	1.00	.95	1.20	1.20
.....	1.50	1.80	1.40	1.25	1.00	1.00	1.10	1.50	1.00	.95	1.15	1.50
.....	1.40	1.70	1.40	1.25	1.00	.90	1.05	1.40	1.00	.90	1.10	2.50
.....	1.40	1.60	1.40	1.20	1.00	.90	1.10	1.20	1.00	.90	1.10	2.90
.....	1.40	1.60	1.35	1.20	1.00	2.15	1.05	1.10	1.00	.90	1.10	1.70
.....	1.40	.....	1.35	1.20	1.00	2.20	1.40	1.10	1.00	.90	1.10	1.40
.....	1.40	.....	1.35	.....	1.20	.....	1.60	1.00	.....	.90	.....	1.20

Rating table for Talladega Creek at Nottingham, Ala., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	20	1.70	172	2.60	374	3.40	588
.90	34	1.80	192	2.70	400	3.50	616
1.00	50	1.90	213	2.80	426	3.60	644
1.10	66	2.00	235	2.90	452	3.70	672
1.20	82	2.10	257	3.00	478	3.80	700
1.30	98	2.20	279	3.10	504	3.90	730
1.40	116	2.30	302	3.20	532	4.00	760
1.50	134	2.40	326	3.30	560	4.10	790
1.60	152	2.50	350				

The above table is poorly defined. It is based upon discharge measurements made during 1903 and 1904. The table has been extended beyond gage height 3 feet.

Estimates of discharges above 4 feet by logarithmic diagram.

Estimated monthly discharge of Talladega Creek at Nottingham, Ala., for 1904.

[Drainage area, 156 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	760	66	152	0.974	1.12
February	700	98	239	1.53	1.65
March	350	107	150	.962	1.11
April	134	82	101	.647	.722
May	82	50	54.4	.349	.402
June	279	20	63.3	.406	.453
July	192	50	78.1	.501	.578
August	1,320	50	278	1.78	2.05
September	116	42	52.5	.337	.376
October	66	34	47.9	.307	.354
November	125	34	69.0	.442	.493
December	452	50	91.7	.588	.678
The year	1,320	20	115	.735	9.99

TALLAPOOSA RIVER AT BUCHANAN BRIDGE, NEAR TALLAPOOSA, GA.

This station was established as a bench-mark station October 21, 1901, by M. R. Hall. It is located at Buchanan Bridge, about 4 miles north

f Tallapoosa, Ga., and about 2 miles above the station on Tallapoosa River at Adderhold Bridge. Discharge measurements are made from he single-span iron highway bridge, having trestle approach of 100 eet on the right bank and 50 feet on the left bank. The initial point 'or soundings is the end of the bridge at the right bank, downstream ide. The channel is straight for about 800 feet above and 1,000 feet elow the station. The current is moderate above and swift below the neasuring section. The banks rarely overflow. The bed of the stream s composed of rock and gravel, free from vegetation, and is probably onstant. There is but one channel at all stages, broken at the higher levels by the piers and trestlework of the bridge. The bench mark is the top of the downstream end of the center floor beam, the third from either end. Its elevation is 25.25 feet above gage datum.

Discharge measurements of Tallapoosa River at Buchanan Bridge, near Tallapoosa, Ga., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 26	W. E. Hall	71	161	1.12	1.55	180
May 14	J. M. Giles	39	96	.41	.83	39
uly 19	W. E. Hall	39	89	.25	.65	22
ugust 31	J. M. Giles	38	99	.59	.81	59
eptember 26	A. T. Mitchelson	40	90	.37	.71	33

TALLAPOOSA RIVER AT ADDERHOLD BRIDGE, NEAR TALLAPOOSA, GA.

This station was established as a bench-mark station January 7, 1901, y M. R. Hall. It is located at Adderhold Bridge, about 2 miles north f Tallapoosa, Ga., and about 2 miles below the station on Tallapoosa iver at Buchanan Bridge. Discharge measurements are made from e downstream side of the single-span iron highway bridge, which as trestle approaches at either end. The initial point for soundings is e end of the bridge at the left bank, downstream side. The channel straight for about 300 feet above and 500 feet below the station. he current is swift above and sluggish below. Both banks are wooded nd are subject to overflow under the trestle approaches during high ater. The bed of the stream is composed of sand, and probably onstant. There is but one channel at all stages, broken during the igher levels by the piers and trestlework of the bridge. The bench nark is the top of the downstream end of the first floor beam from the left bank. Its elevation is 22.00 feet above gage datum.

Discharge measurements of Tallapoosa River at Adderhold Bridge, near Tallapoosa in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Disc
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Secon*
March 9	W. E. Hall	78	250	1.10	1.20	
March 26	M. R. and W. E. Hall.	75	232	.94	1.22	
May 14	J. M. Giles	65	168	.35	.60	
July 19	W. E. Hall	75	159	.20	.30	
August 31	J. M. Giles	78	205	.39	.65	
September 26	A. T. Mitchelson	78	181	.27	.39	

TALLAPOOSA RIVER NEAR HEFLIN, ALA.

This station was established as a bench-mark station. It is lo at Denman's wagon bridge, about 7 miles southwest of Heflin, Al the road to Wedowee, Ala. The elevation of the water surface a time of each discharge measurement is referred to a common da Discharge measurements are made from the downstream side o two-span wooden bridge resting upon three trestle bents and trestle approaches on each side. The floor of the bridge is abo feet above low water. The initial point for soundings is at the c of the trestle bent at the left end of the bridge on the downstream The channel is straight for about 800 feet above and 500 feet belo station. The current is moderate above and sluggish below the uring section. The right bank is high, but is subject to overflow ing high stages. The left bank is high and overflows only at ext high water. The bed of the stream is composed of gravel, free vegetation. There is but one channel at all stages, broken by the supports of the bridge. The section is a fairly good one. At a ford a short distance below, the section is good for wading. The b mark is the top of the downstream end of the cap beam of the c pile bent of the bridge. Its elevation is 24.00 feet above gage da

Discharge measurements of Tallapoosa River near Heflin, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Disc
		Feet.	*Square feet.*	*Foot per sec.*	*Feet.*	*Secon*
September 24	A. T. Mitchelson	107	201	0.68	1.18	
November 3	J. M. Giles	90	142	.44	.80	
November 4	do	98	173	.53	1.15	
December 14	do	114	267	.68	1.67	
December 15	do	114	249	.65	1.60	

TALLAPOOSA RIVER AT STURDEVANT, ALA.

This station was established July 19, 1900, by J. R. Hall. It is cated at the Columbus and Western Railroad bridge, a fourth of a ile west of Sturdevant. This railroad belongs to the Central of eorgia Railway. This station, being above the big new dams at illassee, is intended to replace Milstead station. Map and profile of illapoosa River is published in Twenty-second Annual Report, part

The gage is a vertical timber in two sections. The first section, ading from zero to 5.2 feet, is fastened to a post on the east bank out 20 feet below the bridge. The second section, reading from 5 20 feet, is fastened to the east side of the first pier in the water on e east bank. The gage is read once each day by C. J. Stowe, who paid by the Alabama Geological Survey. At ordinary stages dis-harge measurements are made from a footway supported by the brac-g of the lower chord of the deck bridge. At low stages measure-ents are made from a boat or by wading about 2,000 feet upstream r about 500 feet below the bridge. The initial point for soundings the end of the iron bridge on the east or left bank, downstream side. Distances are marked in white paint along the hand rail of the footway.

The channel is slightly curved directly above the bridge and for bout one-half mile below. The current is swift and much broken by hoals below the bridge, but is sluggish at low stages at and near the tation. Both banks are high, the right overflowing for about 150 eet and the left for about 200 feet. The bed is of rock and gravel nd is probably permanent.

Bench mark No. 1 is a wire nail driven in the southwest corner of he second pier on the east bank. Its elevation is 14.20 feet above he zero of the gage. Bench mark No. 2 is a copper plug set in solid ock in the bed of the river about 80 feet below the bridge, at a point 00 feet from the end of the bridge at the left bank. This is solid ed rock projecting above the water at ordinary stages. Its elevation s 4.89 feet above the zero of the gage. Bench mark No. 3 is a white paint mark on the top of the downstream end of the lower crossbeam at a point 278 feet from the initial point for soundings. Its elevation is 27.65 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tallapoosa River at Sturdevant, Ala., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
May 22	J. M. Giles	378	3,274	1.40	4.00	4,580
July 25[a]	do	228	1,068	2.10	2.45	2,247
August 22[a]	do	236	1,096	1.68	2.20	1,837
August 24	do	269	2,070	.71	1.88	1,485
August 24[a]	do	190	831	1.94	1.86	1,616
October 3[a]	do	165	650	1.28	1.05	834
October 3	do	181	646	1.29	1.05	835
November 24[a]	do	190	806	1.42	1.58	1,148
1904.						
January 25	J. M. Giles	389	2,894	1.28	3.57	3,718
March 11	W. E. Hall	370	2,742	1.04	3.05	2,866
April 12	J. M. Giles	321	2,310	.87	2.40	2,011
May 28[a]	do	165	553	1.08	.65	599
May 28[a]	do	165	558	1.06	.65	592
August 25	do	317	2,219	.74	2.12	1,643
August 26	do	375	2,626	1.13	3.14	2,978
August 27	do	399	3,505	2.37	5.50	8,292
October 13[a]	do	135	422	.77	.03	324
October 13[b]	do	67	305	1.07	.03	326
October 13[c]	do	60	242	1.25	.03	303
October 18[b]	do	66	309	.91	— .10	282
October 18[b]	do	66	301	.91	— .10	273
October 18[b]	do	66	300	.90	— .10	270
December 12[a]	do	180	671	1.47	1.45	984

[a] At shoal one-third mile above Central of Georgia Railroad bridge.
[b] From boat 150 yards below bridge.
[c] From boat 200 yards below bridge.

Main daily gage height, in feet, of Tallapoosa River at Sturdevant, Ala., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.7	2.6	2.8	2.2	1.8	3.2	2.3	3.0	1.6	0.5	−0.1	0.9
.....	1.7	2.8	2.9	2.2	1.9	2.5	2.0	2.8	1.4	.4	.0	1.0
.....	1.8	2.6	3.3	2.1	1.8	2.1	1.9	2.3	1.3	.3	.1	1.4
.....	1.8	2.7	2.9	2.1	1.7	1.8	1.8	3.1	1.2	.2	.3	1.5
.....	1.7	2.7	2.8	2.0	1.6	1.6	1.5	5.4	1.1	.2	.7	1.9
.....	1.7	2.9	2.6	2.0	1.5	1.5	1.1	5.1	1.1	.1	.9	2.5
.....	1.8	3.4	4.9	2.2	1.5	1.4	1.4	5.6	1.6	.1	.9	2.5
.....	1.9	5.8	4.2	3.4	1.5	1.2	1.2	13.4	1.6	.1	.8	2.3
.....	2.4	5.1	3.9	3.4	1.4	1.1	.6	9.1	1.3	.1	.8	2.0
.....	3.3	4.4	3.5	2.9	1.4	1.0	.6	8.5	1.1	.0	.8	1.7
.....	2.8	5.3	3.1	2.7	1.4	.9	.8	7.1	1.0	.0	.7	1.5
.....	2.5	4.8	2.9	2.4	1.3	.9	1.3	6.0	.9	.0	.6	1.4
.....	2.3	4.1	2.7	2.2	1.3	.7	3.0	4.3	.8	.0	.7	1.4
.....	2.3	3.6	3.4	2.1	1.5	.6	1.6	3.5	.8	.0	.7	1.3
.....	2.1	3.3	3.3	2.0	1.4	.6	1.0	3.0	.7	.0	.8	1.2
.....	2.0	3.0	3.3	2.0	1.3	.5	.7	4.5	.7	.0	.9	1.2
.....	3.9	2.9	3.0	2.0	1.3	.5	.6	3.2	.6	.0	.8	1.3
.....	3.4	2.8	2.9	1.9	1.2	.4	.5	3.8	.6	−.1	.9	1.3
.....	3.2	2.8	2.8	1.9	1.2	.3	1.5	3.0	.6	−.1	.8	1.2
.....	3.0	3.6	2.7	1.9	1.1	.2	.6	2.5	.5	.0	.9	1.1
.....	2.6	3.7	2.6	1.9	1.1	.2	.3	2.2	.5	.0	1.0	1.1
.....	3.8	4.6	2.5	1.9	1.0	.4	.6	2.0	.9	−.1	1.2	1.1
.....	5.4	5.1	2.5	1.9	.9	1.2	1.3	1.8	2.0	−.1	2.0	1.1
.....	4.3	4.8	2.5	1.9	.9	1.4	2.8	1.5	2.6	−.1	1.9	1.1
.....	3.6	4.1	2.4	1.8	.8	1.3	1.5	2.1	1.7	−.2	1.5	1.7
.....	3.1	3.6	2.4	2.0	.7	1.0	1.0	3.5	1.0	−.2	1.3	1.8
.....	2.8	3.2	2.4	1.9	.7	.9	.7	5.0	.8	−.2	1.1	3.4
.....	2.5	3.1	2.4	2.0	.6	.8	.7	3.5	.7	−.2	1.0	4.8
.....	2.5	2.9	2.4	2.1	.6	4.4	1.2	2.6	.6	−.2	.9	4.0
.....	2.4	.....	2.3	2.0	.6	2.3	2.5	2.3	.5	−.1	.9	2.9
.....	2.4	.....	2.2	.....	2.8	.....	2.6	1.9	.....	−.1	.....	2.5

ating table for Tallapoosa River at Sturdevant, Ala., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.20	250	1.00	774	2.40	1,985	4.80	6,250
−.10	275	1.10	834	2.60	2,230	5.00	6,740
.00	305	1.20	897	2.80	2,495	5.20	7,240
.10	339	1.30	963	3.00	2,780	5.40	7,760
.20	377	1.40	1,032	3.20	3,085	5.60	8,300
.30	418	1.50	1,105	3.40	3,410	5.80	8,860
.40	462	1.60	1,182	3.60	3,755	6.00	9,430
.50	509	1.70	1,264	3.80	4,120	7.00	12,380
.60	558	1.80	1,352	4.00	4,500	8.00	15,480
.70	609	1.90	1,446	4.20	4,900	9.00	18,690
.80	662	2.00	1,545	4.40	5,330		
.90	717	2.20	1,757	4.60	5,780		

The preceding table is based upon fifteen discharge measurements made during 1904 and some during 1903. Above 6 feet it is based on four measurements made in 1905.

Estimated monthly discharge of Tallapoosa River at Sturdevant, Ala., for 1904.

[Drainage area, 2,500 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	7,760	1,264	2,500	1.00	1.15
February	8,860	2,230	4,089	1.64	1.77
March	6,490	1,757	2,749	1.10	1.27
April	3,410	1,352	1,757	.703	.784
May	2,495	558	991	.396	.456
June	5,330	377	1,084	.434	.484
July	2,780	418	1,086	.434	.500
August	34,200	1,105	5,855	2.34	2.70
September	2,230	509	850	.340	.379
October	509	250	314	.126	.145
November	1,545	275	722	.290	.324
December	6,250	717	1,562	.625	.721
The year	34,200	250	1,966	.786	10.68

LITTLE TALLAPOOSA RIVER 3 MILES NORTH OF WEDOWEE, ALA.

This station was established as a bench-mark station. It is located at "Iron" highway bridge, 3 miles north of Wedowee, Ala., on the Wedowee-Heflin road. Discharge measurements are made from the downstream side of the single-span bridge, the floor of which is 26 to 28 feet above low-water surface. The initial point for soundings is the end of the bridge at the left bank, downstream side. The channel is straight for about 1,000 feet above and 800 feet below the station. The current is moderate. The right bank is fairly high, fringed with trees, and overflows during high water. The left bank is high, wooded above, and cultivated below the bridge, and not subject to overflow. The bed of the stream is composed of clean gravel. There is but one channel at all stages. There is a small sand reef just above the bridge near the right bank; otherwise, this is a good section. Bench mark No. 1 is the top of the large nut on pin connecting eyebars of lower chord at end of first floor beam from the left bank on the downstream side of the bridge. Its elevation is 25.00 feet above gage datum. Bench mark No. 2 is a chisel mark on the intermediate post above the same, downstream end of first floor beam. Its elevation is 32.00 feet above gage datum.

harge measurements of Little Tallapoosa River 3 miles north of Wedowee, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
ember 23 ..	A. T. Mitchelson	130	431	0.54	1.48	236
ember 3 ...	J. M. Giles	115	385	.26	1.20	102

LE TALLAPOOSA RIVER 6 MILES NORTHWEST OF WEDOWEE, ALA.

his station was established as a bench-mark station. It is located he highway bridge about 6 miles northwest of Wedowee and several es above the mouth of the river. Discharge measurements are le from the downstream side of the iron bridge, which consists of ngle span of 140 feet with trestle approaches 100 feet long at each . The floor of the bridge is about 28 feet above low water. The ial point for soundings is the center of the pier at the left bank, nstream side. The channel is straight for about 500 feet above 1,000 feet below the station. The current is swift. Both banks clean, and overflow only under the trestle approach. The bed of stream is composed of rock and gravel, free from vegetation, and onstant. There is but one channel at low water, broken at high er by the piers and trestle approach of the bridge. Bench mark 1 is the downstream end of the second floor beam from the left k. Its elevation is 27.00 feet above gage datum. Bench mark 2 is a chisel mark on the intermediate post at this floor beam. elevation is 32.00 feet above gage datum.

harge measurements of Little Tallapoosa River 6 miles northwest of Wedowee, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage. height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
ember 4 ...	J. M. Giles	120	283	0.44	0.70	124
ember 14...	.....do	125	329	.64	1.02	211
ember 15...	.....do	125	327	.65	1.02	214

CAHABA RIVER AT CENTERVILLE, ALA.

he station was established on August 7, 1901, and is situated at iron highway bridge one-fourth mile west of Centerville, Ala., one- f mile above the Mobile and Ohio Railroad bridge. The bridge is ngle span supported by tubular iron piers.

he chain gage is fastened to the timber fencing along the down- eam side of the bridge. The pulley is 100 feet from the initial

point, which is the end of the iron bridge on the left bank, dc stream side. The length of the chain from the end of the weigl the marker is 51.35 feet. The observer is Clyde Lowrey, who is by the Alabama Geological Survey.

The channel is straight for 1,500 feet above the station and for half mile below. The current is swift. The right bank overflo extreme high water. The left bank overflows only under the appı to the bridge. The bed is nearly all rock, and there is but one cha

Bench mark No. 1 is the downstream end of the floor beam 10(from the initial point for soundings and is 42.85 feet above gage da Bench mark No. 2 is a copper plug set in a solid rock about 6 from the edge of the water and 250 feet below the bridge on th bank. Its elevation is 6.44 feet above gage datum.

The observations at this station during 1904 have been made u the direction of M. R. Hall, district hydrographer.

Discharge measurements of Cahaba River at Centerville, Ala., in 1903 and 190.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Disc
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Secon*
April 8 [a]	J. M. Giles	161	906	1.80	5.15	
April 9 [b]	do	180	1,834	1.21	6.65	
June 17 [a]	do	125	416	1.00	2.05	
June 18 [a]	do	125	414	.95	2.00	
July 20 [a]	do	140	591	1.28	3.23	
July 21 [a]	do	127	482	1.07	2.36	
September 28 [a]	do	107	311	.68	1.31	
September 29 [a]	do	100	314	.69	1.30	
November 8 [a]	do	110	338	.60	1.32	
November 10 [a]	do	100	329	.68	1.40	
1904.						
February 22	Murphy & Giles	145	556	1.54	3.47	
June 25 [c]	J. M. Giles	100	207	1.00	1.29	
August 3	do	128	315	1.33	1.97	
August 4	do	128	304	1.25	1.88	
October 31	do	113	189	.54	.86	
October 31	do	113	196	.55	.88	

[a] Measurement taken at wagon bridge.
[b] Measurement taken at Mobile and Ohio Railroad bridge.
[c] Channel silted badly.

Mean daily gage height, in feet, of Cahaba River at Centerville, Ala., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	2.9	2.6	2.2	1.6	1.5	1.3	1.6	1.2	1.0	0.9	1.1
2	1.5	2.9	2.5	2.3	1.6	1.4	1.4	1.6	1.2	1.0	.9	1.1
3	1.6	2.9	2.4	2.2	1.6	1.2	1.3	2.0	1.1	.9	1.3	1.1
4	1.5	2.7	2.3	2.1	1.6	1.2	1.5	2.2	1.7	.9	1.3	1.1
5	1.5	2.6	2.2	2.1	1.5	1.2	1.4	2.0	1.5	.9	1.1	2.0
6	1.5	2.8	3.0	2.1	1.5	1.2	1.3	2.0	1.4	.9	1.1	2.2
7	1.8	6.7	6.4	2.2	1.4	1.3	1.8	7.1	1.2	.9	1.0	2.0
8	1.9	11.5	7.0	2.6	1.5	2.5	1.2	5.5	1.3	.9	1.0	1.9
9	2.2	6.0	5.4	3.1	1.5	1.7	1.6	5.1	1.3	1.0	1.0	1.7
10	2.8	6.4	4.2	2.6	1.6	1.6	1.7	4.7	1.2	1.0	1.0	1.5
11	3.1	10.0	3.8	2.4	1.6	1.6	1.5	3.7	1.1	1.0	1.0	1.4
12	2.2	7.2	3.4	2.3	1.7	1.4	1.3	3.7	1.2	.9	1.0	1.4
13	2.0	5.5	3.1	2.2	1.6	1.3	1.2	3.8	1.1	.9	1.0	1.4
14	1.8	5.4	3.8	2.1	1.6	1.3	1.3	2.8	1.1	.9	1.0	1.3
15	1.8	4.6	5.4	2.1	1.5	1.2	1.2	5.6	1.1	.9	1.0	1.3
16	1.8	4.1	4.3	2.0	1.4	1.2	1.2	3.6	1.0	.9	1.0	1.2
17	2.9	3.3	3.9	2.0	1.4	1.1	1.3	2.5	1.0	.9	1.0	1.2
18	2.6	3.1	3.6	2.0	1.3	1.1	1.3	2.0	1.0	.9	1.0	1.2
19	2.4	3.0	3.5	1.9	1.3	1.1	1.2	1.8	1.0	.9	1.0	1.2
20	2.1	3.8	3.3	1.9	1.3	1.1	1.1	1.6	1.1	.9	1.0	1.2
21	2.0	3.3	3.0	1.8	1.3	1.0	1.1	1.4	1.1	.9	1.2	1.2
22	10.2	3.5	2.9	1.7	1.3	1.0	1.1	1.4	1.0	.9	1.2	1.1
23	8.8	3.3	2.8	1.7	1.2	1.0	1.6	1.3	1.0	.9	1.3	1.1
24	4.8	3.2	2.8	1.6	1.2	1.2	1.3	1.3	1.0	.8	1.3	1.1
25	3.4	3.1	2.7	1.6	1.2	1.3	1.3	1.2	1.0	.8	1.3	1.7
26	3.0	3.0	2.6	1.7	1.2	1.2	1.2	1.5	1.0	.8	1.2	2.0
27	2.4	2.9	2.4	1.7	1.2	1.3	1.4	1.3	1.0	.8	1.1	3.1
28	2.6	2.8	2.3	1.6	1.3	1.2	2.1	1.3	1.0	.8	1.1	4.7
29	2.7	2.7	2.2	1.6	1.2	1.1	1.7	1.2	1.0	.8	1.1	6.0
30	2.9	.....	2.1	1.6	1.4	1.0	1.7	1.5	1.0	.9	1.1	5.1
31	2.8	.....	2.0	.....	1.6	.....	1.6	1.3	.....	.9	.....	2.6

Rating table for Cahaba River at Centerville, Ala., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	90	1.70	318	2.50	560	3.60	911
.90	111	1.80	348	2.60	591	3.80	982
1.00	133	1.90	378	2.70	622	4.00	1,056
1.10	156	2.00	408	2.80	653	4.20	1,131
1.20	180	2.10	438	2.90	684	4.40	1,207
1.30	205	2.20	468	3.00	715	4.60	1,285
1.40	232	2.30	498	3.20	779	4.80	1,366
1.50	260	2.40	529	3.40	844	5.00	1,450
1.60	289						

The above table is based upon discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 0.8 foot and 3.5 feet. Above 3.5 feet the curve is uncertain, as the high-water measurements are inconsistent.

Estimated monthly discharge of Cahaba River at Centerville, Ala., for 1904.

[Drainage area, 1,040 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maxium.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,215	260	721	0.693	0.799
February	5,060	591	1,290	1.24	1.34
March	2,395	408	866	.833	.960
April	747	289	419	.403	.450
May	318	180	241	.232	.268
June	560	133	205	.197	.220
July	438	156	233	.224	.258
August	2,445	180	623	.599	.691
September	318	133	165	.159	.177
October	133	90	110	.106	.122
November	205	111	153	.147	.164
December	1,900	156	397	.382	.440
The year	5,060	90	452	.435	5.89

TOMBIGBEE RIVER AT COLUMBUS, MISS.

The gage is located about 1,000 feet below the county highway bridge, 1 mile from the Southern Railway station at Columbus, Miss. A vertical 3 by 10 inch pine timber is fastened to the blue-rock bluff on the left bank and is marked with brass figures and brass nails from −5 to +43 feet. Discharge measurements are made from the county highway bridge at the south end of Main street. The initial point for soundings is the end of the iron bridge on the right bank, downstream side. The channel is slightly curved for 500 feet above and 1,000 feet below the station. The current is sluggish at low stages and very swift above a gage height of 12 feet. The right bank is high and seldom overflows. The left bank overflows from gage height 18 to 22 feet. The bed of the stream is of soft blue rock.

Bench mark No. 1 is the top of the downstream girder at a point 250 feet from the initial point for soundings. Its elevation is 39.88 feet above the zero of the gage. This point is on the movable portion of the drawbridge and may vary in elevation. Bench mark No. 2 is a copper plug in a tree at the southeast corner of First street and Second avenue. Its elevation is 17.94 feet above the zero of the gage. This tree has boards nailed to it, showing the names of the streets. Bench mark No. 3 is the top of the rail at the depot of the Southern Railway and is 55.20 feet above gage datum and 191 feet above mean sea level.

observer, J. J. Richards, is paid by the United States Weather u.

width of the river at low water is 160 feet. The maximum ed height of the river was on April 8, 1892, when the gage reg- l 42 feet. The lowest recorded height was on October 26, 1893, he gage reading was −3.9 feet. The danger line is at 33 feet. observations at this station during 1904 have been made under ection of M. R. Hall, district hydrographer.

harge measurements of Tombigbee River at Columbus, Miss., in 1903 and 1904.

ate.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
03.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
9.....	J. M. Giles	307	5,884	4.49	15.50	26,450
12.....	.....do	317	6,586	4.40	17.30	29,020
.....	.....do	297	4,655	3.82	12.50	17,800
.....	.....do	88	1,040	1.29	− 1.70	1,340
.....	.....do	88	1,034	1.24	− 1.80	1,278
ber 22 ..	.....do	55	805	.31	− 3.70	252
ber 25[a] .	.....do	116	187	1.40	− 3.70	263
04.						
13.....	J. M. Giles	104	1,072	1.06	− 1.80	1,137
16.....	.....do	105	1,107	.97	− 2.00	1,072
ry 25 ...	J. M. Giles and E. C. Murphy.	119	1,230	1.86	− .30	2,290
23.....	W. E. Hall	133	1,359	2.14	.30	2,913
13.....	J. M. Giles	120	1,216	1.87	− .50	2,270
29[b].....	.....do	66	128	1.27	− 3.80	162
29[b].....	.....do	66	128	1.23	− 3.80	58

ured 1 mile below wagon bridge, which is about one-third mile below the Mobile and Ohio bridge.
boat at shoal, one-third mile below Mobile and Ohio Railroad bridge.

Mean daily gage height, in feet, of Tombigbee River at Columbus, Miss., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	−1.8	1.6	−1.3	4.6	−1.3	−2.3	−1.6	−1.8	−3.3	−2.8	−3.1	−2.2
2	−1.9	1.0	− .8	5.3	−1.3	−2.4	−1.6	−1.8	−3.3	−2.8	−3.0	−2.2
3	−1.6	.4	− .6	6.0	−1.3	−2.4	−1.7	−1.2	−3.2	−2.9	−2.8	−1.8
4	−1.4	.0	− .6	6.2	−1.5	−2.3	−1.5	−1.2	−3.2	−2.9	−2.4	−1.6
5	−1.4	− .4	− .8	6.0	−1.6	−2.3	−1.7	−1.1	−3.2	−2.9	−2.4	−1.6
6	−1.6	− .4	− .5	6.0	−1.6	−2.4	−1.7	−1.0	−3.2	−2.9	−2.4	−1.6
7	−1.4	− .3	− .1	5.5	−1.6	−1.8	−1.9	− .9	−3.3	−2.9	−2.4	−1.6
8	−1.4	− .3	− .2	5.2	−1.6	−1.5	−1.9	− .7	−3.3	−2.9	−2.4	−1.6
9	−1.6	− .6	− .1	5.0	−1.6	−1.5	−1.8	− .7	−3.3	−2.9	−2.4	−1.6
10	−1.6	− .4	− .1	4.6	−1.6	−1.6	−1.9	− .6	−3.4	−2.9	−2.4	−1.6
11	−1.6	− .2	1.0	4.2	−1.8	−1.8	−1.9	− .6	−3.4	−2.9	−2.4	−1.7
12	−1.6	− .2	1.0	4.0	−1.8	−1.8	−1.8	.0	−3.5	−2.9	−2.4	−1.8
13	−1.5	− .5	1.0	3.7	−1.9	−1.9	−1.8	− .4	−3.5	−2.9	−2.5	−1.8
14	−1.6	− .7	1.2	2.4	−2.0	−1.9	−2.0	− .8	−3.5	−2.9	−2.6	−1.8
15	−1.7	− .8	1.3	3.0	−2.2	−2.0	−2.2	−1.0	−3.5	−2.9	−2.6	−1.8
16	−1.7	−1.0	1.3	2.8	−2.3	−2.0	−2.6	−2.0	−3.5	−3.0	−2.6	−1.8
17	−2.0	−1.1	1.0	2.0	−2.3	−2.0	−2.6	−2.5	−3.5	−3.0	−2.6	−1.8
18	−1.9	−1.2	1.7	1.6	−2.3	−2.0	−2.7	−2.9	−3.5	−3.0	−2.6	−1.8
19	−1.9	−1.2	1.6	.8	−2.4	−2.1	−2.8	−2.9	−3.5	−3.0	−2.6	−1.8
20	−1.9	−1.1	1.4	.4	−2.4	−2.2	−2.9	−2.9	−3.5	−3.0	−2.6	−1.8
21	−2.0	−1.0	1.7	.1	−2.4	−2.2	−2.9	−3.1	−3.5	−3.0	−2.6	−1.8
22	−1.6	− .8	1.7	.0	−2.4	−2.2	−2.8	−3.2	−3.2	−3.0	−2.4	−1.8
23	−1.6	−1.0	1.7	− .3	−2.4	−2.3	−2.2	−3.2	−3.2	−3.0	−2.4	−1.8
24	.0	− .9	1.4	− .5	−2.4	−2.3	−2.0	−3.1	−2.8	−3.0	−2.4	−1.9
25	1.0	− .9	1.4	− .6	−2.5	−2.3	−1.9	−3.1	−2.8	−3.0	−2.4	−1.8
26	.....	− .3	2.6	− .6	−2.5	−2.3	−1.9	−3.1	−2.8	−3.0	−2.5	−1.7
27	1.7	− .7	2.8	− .8	−2.5	−2.3	−1.5	−3.1	−2.8	−3.0	−2.5	−1.5
28	1.9	− .9	2.9	− .9	−2.5	−1.8	− .8	−3.2	−2.8	−3.0	−2.5	−1.4
29	2.0	−1.3	3.5	−1.0	−2.5	−2.0	− .8	−3.2	−2.8	−3.0	−2.5	−1.0
30	1.4	.....	3.5	−1.2	−2.5	−1.8	−1.2	−3.3	−2.8	−3.1	−2.2	1.5
31	1.6	.....	3.5	.....	−2.3	.....	−1.5	−3.3	.....	−3.1	.....	2.5

Rating table for Tombigbee River at Columbus, Miss., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−4.00	100	−2.80	620	−0.60	2,120	1.60	4,210
−3.90	130	−2.60	720	− .40	2,290	1.80	4,430
−3.80	160	−2.40	830	− .20	2,470	2.00	4,650
−3.70	190	−2.20	950	.00	2,650	2.50	5,200
−3.60	230	−2.00	1,070	.20	2,830	3.00	5,800
3.50	270	−1.80	1,200	.40	3,010	3.50	6,400
−3.40	320	−1.60	1,340	.60	3,200	4.00	7,050
−3.30	370	−1.40	1,480	.80	3,400	4.50	7,700
−3.20	420	−1.20	1,640	1.00	3,600	5.00	8,350
−3.10	470	−1.00	1,800	1.20	3,800	5.50	9,000
−3.00	520	− .80	1,960	1.40	4,000	6.00	9,700

The above table is based upon discharge measurements made from 1901 to 1904. *It is fairly* well defined. Above 7 feet the 1903 and 1904 rating tables are identical.

Estimated monthly discharge of Tombigbee River near Columbus, Miss., for 1904.

[Drainage area, 4,440 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,650	1,070	1,991	0.448	0.516
February	4,210	1,560	2,209	.498	.537
March	6,400	1,560	3,785	.852	.982
April	9,980	1,640	5,456	1.23	1.37
May	1,560	770	1,059	.239	.276
June	1,410	830	1,041	.234	.261
July	1,960	570	1,135	.256	.295
August	2,650	370	1,175	.265	.306
September	620	270	402	.091	.102
October	620	470	544	.123	.142
November	950	470	765	.172	.192
December	5,200	950	1,475	.332	.383
The year	9,980	270	1,753	.395	5.36

BLACK WARRIOR RIVER NEAR CORDOVA, ALA.

This station is located at the Kansas City, Memphis and Birmingham Railroad bridge, which crosses the river below the junction of the Mulberry and Sipsey forks, and about three-fourths of a mile from Cordova, Ala. The gage was established by the United States Weather Bureau, but observations by that bureau have been discontinued. From 12 to 55 feet the gage is a vertical timber bolted to the inside of the bridge pier on the left bank of the river. Below 12 feet the gage was sloping, but it was out of position and could not be used when the station was established by the United States Geological Survey on May 21, 1900, so a short new section was put in at that time. This section is a 2 by 10 inch plank, graduated to feet and tenths, from −1.5 to +12.5 feet, and spiked to a willow tree on the right bank of the river about 200 feet below the bridge.

Measurements are made from the downstream side of the railroad bridge, which is a two-span iron through bridge. The span across the river is 300 feet long. A pier is being built in the river, and the long span will be replaced by two shorter ones. The span on the left bank is about 150 feet long. At low stages discharge measurements are made from a boat or by wading at a point some distance below the bridge. The channel is curved for 500 feet above and straight for 1,000 feet below the station. The right bank is a rock bluff and will not overflow. The left bank overflows only under the second span of the bridge. The bed of the stream is of rock and is permanent. The

channel has a width of about 180 feet at low water and about 450 feet at high stages.

Bench mark No. 1 is the top of the fourth crossbeam from the right bank, on the downstream side. Its elevation is 60.09 feet above the zero of the gage. Bench mark No. 2 is a copper plug in the solid rock about 110 feet above the bridge, 50 feet from the initial point for soundings. Its elevation is 32.12 feet above the zero of the gage. The top of the pier at the left bank is 55.10 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Black Warrior River near Cordova, Ala., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 6	J. M. Giles	240	4,225	4.56	13.90	19,250
March 13	do	220	2,625	3.61	6.90	9,486
May 19	do	206	1,991	2.59	4.34	5,159
June 15	do	184	1,261	.82	.50	1,036
July 17 [a]	do	178	576	.53	− .30	306
August 27 [b]	do	182	546	.38	− .48	208
August 29 [b]	do	181	501	.28	− .65	142
September 25 [c]	do	137	134	.58	− .90	78
1904.						
January 16 [a]	J. M. Giles	182	554	.39	− .40	216
February 24	J. M. Giles and E. C. Murphy.	181	1,200	.65	.28	785
March 23	M. R. and W. E. Hall.	191	1,638	1.88	2.65	3,086
May 25 [b]	J. M. Giles	180	509	.34	.50	171
August 10	do	185	1,263	.80	.49	1,011
October 26 [d]	do	48	75	.34	− 1.00	25
October 26 [d]	do	48	72	.34	− 1.00	24

[a] One-fourth mile below Frisco System Railroad bridge.
[b] One-third mile below Frisco System Railroad bridge.
[c] At fish trap 3 miles below bridge.
[d] Boat 100 yards above Southern Railway bridge.

daily gage height, in feet, of Black Warrior River near Cordova, Ala., for 1904.

ay.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	−0.4	−0.1	0.0	2.6	−0.5	1.2	1.8	−0.5	−0.8	−1.0	−0.9	0.8
.....	− .4	.0	.0	2.4	− .5	.4	.2	− .3	− .8	−1.0	− .9	.9
.....	− .5	.1	.0	3.2	− .5	− .1	− .3	.6	− .8	−1.0	− .9	1.3
.....	− .5	.0	.0	3.1	− .4	− .6	− .1	.4	− .5	−1.0	− .3	2.2
.....	− .5	− .1	.0	2.8	− .4	− .4	− .3	.4	− .5	−1.0	.1	3.8
.....	− .5	− .1	.0	2.4	− .5	− .3	− .3	.6	− .6	−1.0	− .3	5.5
.....	− .5	− .1	3.2	3.7	− .5	− .2	.2	.6	− .7	−1.0	− .3	2.7
.....	− .4	.3	5.4	5.2	.3	− .1	− .1	1.2	− .8	−1.0	− .4	1.3
.....	− .4	.1	3.5	7.2	.4	− .3	− .3	1.0	− .8	−1.0	− .4	1.1
.....	− .5	.4	2.3	4.3	.6	− .4	− .4	.9	− .8	−1.0	− .5	1.2
.....	− .5	.7	2.0	4.0	.5	− .5	− .2	1.1	− .8	− .9	− .5	.9
.....	− .5	.6	2.0	3.2	.4	− .5	.3	1.1	− .8	− .9	− .5	.7
.....	− .5	.4	2.4	2.5	.2	− .5	2.7	1.2	− .8	− .9	− .5	.4
.....	− .5	.4	5.5	2.1	.0	− .5	.6	.8	− .8	− .9	− .5	.2
.....	− .5	.3	6.8	1.6	− .1	− .5	− .1	.3	− .8	− .9	− .5	.1
.....	− .5	.2	4.5	1.5	− .2	− .5	− .4	.1	− .8	− .9	− .6	.0
.....	− .3	.1	3.2	1.2	− .2	− .6	− .3	.1	− .8	− .9	− .6	.1
.....	− .3	.1	2.5	1.1	− .3	− .6	− .5	.0	− .8	− .9	− .6	− .1
.....	− .2	.0	2.2	1.0	− .4	− .6	− .3	− .1	− .9	− .9	− .6	.0
.....	− .2	.0	1.4	1.0	− .5	− .6	− .5	− .2	− .9	− .9	− .6	.0
.....	− .2	.3	.5	1.0	− .6	− .7	− .4	− .2	− .9	− .9	− .6	.1
.....	1.3	.3	.3	1.1	− .6	− .7	− .4	− .3	− .9	− .9	.6	− .1
.....	2.9	.4	.3	1.5	− .6	− .8	− .5	− .4	− .9	− .9	− .1	− .2
.....	2.0	.3	5.5	1.4	− .6	− .8	− .4	− .5	− .9	− .9	.1	.2
.....	1.6	.3	5.5	− .1	− .6	− .5	− .3	− .6	− .9	− .9	.1	.2
.....	.6	.2	4.1	− .1	− .6	− .5	.3	− .7	− .9	− .9	.0	.0
.....	.3	.1	6.5	− .1	− .6	− .5	− .4	− .7	− .9	− .9	.0	.2
.....	.1	.1	8.6	− .2	− .6	− .5	− .5	− .7	− .9	− .9	− .1	12.4
.....	.1	.0	5.7	− .4	− .6	− .4	− .5	− .7	−1.0	− .9	− .1	6.5
.....	.0	.....	4.3	− .5	− .6	2.6	− .5	− .8	−1.0	− .9	− .1	3.8
.....	.0	.....	2.8	.....	1.3	.....	.5	− .8	.....	− .9	.....	2.4

Rating table for Black Warrior River near Cordova, Ala., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−1.00	28	0.00	560	1.00	1,450	3.00	3,540
−.90	53	.10	645	1.20	1,630	3.20	3,780
−.80	80	.20	730	1.40	1,820	3.40	4,030
−.70	110	.30	820	1.60	2,010	3.60	4,290
−.60	145	.40	910	1.80	2,210	3.80	4,550
−.50	190	.50	1,000	2.00	2,410	4.00	4,820
−.40	250	.60	1,090	2.20	2,615	4.50	5,520
−.30	320	.70	1,180	2.40	2,830	5.00	6,230
−.20	400	.80	1,270	2.60	3,060	5.50	6,955
−.10	480	.90	1,360	2.80	3,300	6.00	7,700

The above table is based upon twenty-six discharge measurements made during 1900–1904. It is well defined between gage heights −1.0 feet and 6.0 feet. The table has been extended beyond these limits, being based on three high-water measurements. Above gage height 6 feet the rating curve is a tangent, the difference being 150 per tenth.

Estimated monthly discharge of Black Warrior River near Cordova, Ala., for 1904.

[Drainage area, 1,900 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,420	190	613	0.323	0.372
February	1,180	480	720	.379	.409
March	11,600	560	3,818	2.01	2.32
April	9,500	190	2,606	1.37	1.53
May	1,725	145	409	.215	.248
June	3,060	80	378	.199	.222
July	3,180	190	516	.272	.314
August	1,630	80	693	.365	.421
September	190	28	78.0	.041	.046
October	53	28	44.9	.024	.028
November	645	53	298	.157	.175
December	17,300	400	2,277	1.20	1.38
The year	17,300	28	1,038	.546	7.46

BLACK WARRIOR RIVER AT TUSCALOOSA, ALA.

A continuous record of gage heights at Tuscaloosa since 1889 has been kept by the United States Engineer Corps. During 1895 and 1896 a number of discharge measurements were also made, from which a rating table was obtained, and since that time measurements of flow have been made by the United States Geological Survey. The station is located about one-fourth of a mile above Mobile and Ohio Railroad bridge. There are three locks and dams within about 3 miles above the station.

The gage is located about three-fourths of a mile from the business center of Tuscaloosa, Ala. It is reached by passing down Bridge street to the river, thence down the east bank 1,800 feet. There is also a vertical iron gage on the downstream side of the second pier from the left bank of the highway bridge, from which the discharge measurements are made. Discharge measurements are made from the iron highway bridge above the gage. The initial point for soundings is the end of the iron bridge on the left bank, downstream side. The channel is straight for 15,000 feet above and below the station; its width at low water is 280 feet and at high stages 625 feet. The current is sluggish at low stages. Both banks are high and steep and overflow only at extreme stages. The greater part of the bed is of rock and is permanent. There is but one channel, broken by the three bridge piers.

Bench mark No. 1 is on a willow tree 10 feet west of the gage; its elevation is 10.54 feet above the zero of the gage and 97.34 feet above the Mobile datum. Bench mark No. 2 is on a small hackberry tree 30 feet south of the upper end of the gage; its elevation is 52.06 feet above the zero of the gage and 139.36 feet above the Mobile datum. Daily gage heights are furnished to the Geological Survey by the United States engineers.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Black Warrior River at Tuscaloosa, Ala., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
July 20	J. M. Giles	229	1,433	0.60	5.45	862
July 21	do	229	1,448	.50	5.44	719
1904.						
February 23	J. M. Giles and E. C. Murphy.	257	1,978	1.23	7.40	2,433
August 22	do	247	1,536	.66	5.57	1,021
August 22	do	247	1,532	.64	5.57	976

Mean daily gage height, in feet, of Black Warrior River at Tuscaloosa, Ala., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.02	6.40	6.57	13.06	6.85	5.10	8.15	5.29	4.90	4.38	4.12	.....
2	5.00	6.35	6.42	12.20	6.75	6.40	9.80	5.29	4.93	4.35	4.12	.....
3	5.03	6.40	6.40	12.25	6.40	6.91	8.10	5.55	4.82	4.36	4.23	.....
4	5.01	6.37	6.31	12.10	6.21	6.50	6.91	6.53	4.78	4.38	4.70	.....
5	4.98	6.30	6.23	11.05	5.98	6.01	6.63	6.89	4.60	4.40	4.70	.....
6	4.95	6.28	6.05	10.10	5.85	5.53	5.90	6.70	4.80	4.40	4.61	.....
7	5.06	6.30	9.30	9.91	5.64	5.50	5.45	7.32	4.87	4.29	4.66	.....
8	5.18	6.70	15.75	12.30	5.53	5.45	5.40	9.50	4.90	4.30	4.83	.....
9	5.10	7.68	17.50	18.48	5.42	5.35	6.00	9.90	4.85	4.29	4.75	.....
10	5.41	8.75	15.25	20.55	5.98	5.30	7.98	9.73	4.90	4.29	4.66	.....
11	5.32	11.05	12.94	18.13	6.17	5.31	7.71	8.17	4.80	4.30	4.65	.....
12	5.51	12.16	11.07	15.00	6.08	5.30	7.02	8.39	4.71	4.35	4.55	.....
13	5.40	10.73	10.21	13.13	5.95	5.28	7.22	10.30	4.70	4.33	4.48	.....
14	5.28	9.55	10.85	11.45	5.80	5.20	9.00	10.55	4.69	4.33	4.40	.....
15	5.15	8.70	17.60	10.20	5.63	5.10	8.82	9.24	4.65	4.33	4.36	.....
16	5.08	8.07	22.24	8.50	5.40	5.10	7.40	8.40	4.60	4.33	4.34	.....
17	5.32	7.53	19.00	8.45	5.21	5.00	7.00	7.52	4.50	4.15	4.30	.....
18	5.60	7.10	15.34	8.35	5.18	4.80	6.90	6.92	4.50	4.15	4.25	.....
19	5.50	6.80	13.10	8.15	5.10	4.70	5.50	6.87	4.50	4.15	4.30	.....
20	5.49	6.80	11.73	7.80	5.08	4.62	5.31	6.44	4.46	4.17	4.25	.....
21	5.50	7.05	10.71	7.45	5.06	4.60	5.23	6.16	4.45	4.17	4.27	.....
22	6.70	7.35	9.86	7.15	5.00	4.43	4.70	5.59	4.44	4.16	4.70	.....
23	11.68	7.45	9.25	7.09	5.00	4.30	5.10	5.33	4.43	4.15	4.71	.....
24	12.70	7.36	9.40	7.01	4.98	4.21	5.38	5.14	4.40	4.15	4.70	.....
25	11.15	7.31	14.00	7.40	4.95	3.98	5.60	5.08	4.40	4.15	4.59	.....
26	9.48	7.23	15.40	7.41	4.91	3.85	5.75	4.80	4.38	4.15	4.55	.....
27	8.20	7.12	14.71	7.20	4.88	4.54	5.40	4.84	4.35	4.15	4.57	.....
28	7.40	6.84	18.50	7.18	4.86	4.88	5.38	4.90	4.34	4.15	4.54	.....
29	6.90	6.71	20.60	7.15	4.80	4.80	5.40	4.98	4.40	4.15	4.44	.....
30	6.65	.....	17.85	7.10	4.81	4.75	5.12	5.15	4.40	4.14	4.25	.....
31	6.40	.....	15.03	.....	4.95	.....	5.24	4.78	.....	4.13	.....	.....

CLEAR CREEK NEAR ELK, ALA.

This station was established June 22, 1904, by M. R. Hall. It is cated at the wagon bridge 1 mile south of Elk, and 15 miles north f Jasper, on the road to Houston. The bridge is about one-fourth ile above Clear Creek Falls, and about 2 miles above the junction of lear Creek with Sipsey Fork of Black Warrior River. The gage is a ertical timber graduated from zero to 10 feet, fastened to a 3-inch by -inch pine timber which is bolted to the right side of the right-bank cone pier under the upstream side of the bridge. It is read once each ay by J. S. Gossett. This station is maintained in cooperation with e Alabama Geological Survey, by whom the gage reader is paid. Discharge measurements are made from the upstream side of the ridge to which the gage is attached. This is an iron wagon bridge, aving a single span of 100 feet, and a 49-foot trestle approach on the ight bank. The initial point for soundings is the end of the bridge t the left bank on the upstream side. The channel is straight for bout 400 feet above and 500 feet below the station. The current above he station is rather sluggish at low stages; below, it is swift and roken. The right bank is low, wooded, and is liable to overflow, ut all the water passes under the bridge and trestle. The left bank high, rocky, clean, and is not subject to overflow. The bed of the ream is composed of rock and clean sand, and is permanent. There one channel at all stages. At very low water the current is too uggish for measurement at the bridge, but measurements are made wading at the falls below. Bench mark No. 1 is the top of the ter, upstream eyebar, at a point 35 feet from the initial point for undings. Its elevation is 17.10 feet above the zero of the gage. ench mark No. 2 is a copper plug set in rock on the left bank about feet upstream from the end of the bridge. Its elevation is 17.04 et above the zero of the gage.

Discharge measurements of Clear Creek near Elk, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
ly 24	J. M. Giles	86	86	0.45	0.79	39
ne 22 [a]	do	26	14	1.05	.66	15
gust 9	do	96	84	.56	.81	47
tober 25	do	94	77	.22	.65	17
tober 25 [b]	do	34	19	.90	.65	17

[a] Wading at upper falls. [b] Wading 150 yards below bridge.

Mean daily gage height, in feet, of Clear Creek near Elk, Ala., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.80	0.75	0.85	0.65	0.65	0.90
2	.....	.80	.75	.70	.65	.65	1.00
3	.....	.80	.80	.70	.65	.80	1.00
4	.....	.80	1.10	.70	.65	.80	1.30
5	.....	.90	.95	.70	.65	.75	1.00
6	.....	.90	.95	.65	.70	.75	1.00
7	.....	.95	.90	.65	.70	.75	1.50
8	.....	1.00	1.10	.70	.70	.75	1.20
9	.....	1.10	.80	.70	.70	.80	.90
10	.....	1.00	.80	.70	.65	.90	.90
11	.....	.90	.75	.70	.65	.80	.90
12	.....	1.10	.80	.65	.65	.75	.90
13	.....	1.10	.80	.65	.65	.70	.85
14	.....	.90	1.00	.65	.60	.70	.85
15	.....	.90	1.00	.65	.60	.70	.80
16	.....	.90	1.00	.60	.60	.70	.75
17	.....	.85	1.00	.60	.60	.70	.75
18	.....	.85	1.10	.60	.60	.70	.75
19	.....	.85	1.00	.60	.60	.70	.75
20	.....	.85	1.00	.60	.60	.70	.75
21	.....	.95	1.00	.65	.60	.70	.75
22	.....	1.60	1.00	.60	.60	.75	.75
23	0.65	1.20	.90	.60	.60	.80	.75
24	.65	1.10	.90	.65	.60	.80	.75
25	.65	1.00	1.00	.65	.60	.85	.80
26	.70	.95	1.00	.65	.60	.85	.85
27	.80	.95	.90	.70	.60	.85	1.80
28	.80	.95	.90	.65	.60	.85	1.70
29	2.60	.80	.90	.70	.60	.90	1.65
30	1.20	.80	.90	.70	.60	.90	1.40
31	.....	.80	.85	.....	.60	.....	1.20

BLACK WATER CREEK NEAR JASPER, ALA.

This station was established as a bench-mark station. It is located 100 yards below the dam at Camack's mill, 6 miles north of Jasper, Ala. Discharge measurements are made from the single-span iron highway bridge with short trestle approaches at either end. The initial point for soundings is the end of the bridge at the right bank, upstream side. The channel is straight for about 200 feet above and 500 feet below the station. The current is swift. Both banks are wooded, and liable to overflow under the trestle approaches. The bed of the stream is rocky and permanent. There is but one channel at all stages, broken during high water by the piers and trestle work of the bridge. The bench mark is the top of the upstream eyebar, 49 feet from the right-bank end of the bridge. Its elevation is 20.00 feet above the gage datum.

Discharge measurements of Black Water Creek near Jasper, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Foot per sec.*	*Feet.*	*Second-feet.*
May 24	J. M. Giles	42	35.6	0.63	1.10	22.5
August 9	do	41	40.0	.97	1.27	39
October 25[a]	do	3.5	2.3	.91	.75	2.1

[a] Mill not running, water being stored in pond.

BLACK WARRIOR RIVER (LOCUST FORK) AT PALOS, ALA.

Locust Fork of Black Warrior River rises in Blount County, Ala., and, flowing in a southwesterly course, enters Black Warrior River a short distance above Wilmington, Ala. Its drainage basin is hilly, and only a small part of its area is in cultivation. Palos station was established November 26, 1901, by R. C. McCalla, United States assistant engineer, who furnishes the daily gage heights to the United States Geological Survey. It is maintained by the United States Engineer Corps. The gage is a 4 by 8 inch timber, on the right bank of the river, just below the Kansas City, Memphis and Birmingham Railroad bridge. One section follows the slope of the bank from low water to a tree on top of the bank, and from there up a vertical section is fastened to the tree. The slope is 17 feet in elevation, measured vertically, and the vertical section of the rod is 15 feet. The rod is graduated to feet and tenths, with copper figures at the 5-foot points and roundhead tacks at intermediate foot marks. The total height is 32 feet. The datum of gage (about 251.71 feet above Mobile datum) is supposed to be extreme low water. High water, April, 1900, was about 37 feet.

Measurements are made from the Drennan Bridge, which is about a quarter of a mile below the Kansas City, Memphis and Birmingham Railroad bridge. The Drennan Bridge is the property of the Drennan Coal Mining Company. It is a mining railroad bridge, having width for a double-track tramway of 3 feet gage. One track is laid and in operation. The bridge has two iron spans of 100 feet each and trestle approaches at both ends.

Low-water measurements are made by wading at a shoal one-third mile below the bridge. The initial point for soundings is the left-bank end of the iron bridge on the downstream side. The channel is curved for 1,500 feet above the station and is straight for 3,000 feet below. At low water the channel is 180 feet wide. There is a ledge of rock about 200 feet below the station with about 3 feet fall. Both banks are high and wooded. The right bank overflows at flood stages, but only under the approach to the bridge. The bed is mainly of rock and is permanent.

Bench mark No. 1 is the top of the crossbeam at a point 80 fee the left end of the bridge on the downstream side. Its ele is 46.70 feet above the surface of the water, less the reading gage. It was established by measuring down to water surface steel tape. Bench mark No. 2 is a copper plug in a water-oak t the right hand, 20 feet downstream from the gage. Its eleva 21.68 feet above the zero of the gage.

The observations at this station during 1904 have been made the direction of M. R. Hall, district hydrographer.

Discharge measurements of Black Warrior River (Locust Fork) at Palos, Ala., and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Di
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Se*
March 7 [a]	J. M. Giles	172	1,937	3.85	4.75	
March 14 [a]	do	168	1,735	3.08	3.55	
May 20 [a]	do	156	1,358	1.58	1.75	
June 16 [a]	do	130	1,065	.40	.62	
June 16 [a]	do	130	1,041	.39	.62	
July 18 [b]	do	96	249	.91	.40	
August 28 [b]	do	77	195	.43	.13	
August 28 [c]	do	100	246	.38	.13	
September 26 [d]	do	88	93	.50	.02	
1904.						
January 18 [b]	J. M. Giles	93	243	.62	.38	
March 24 [a]	M. R. and W. E. Hall.	156	1,305	1.28	1.58	
May 23 [b]	J. M. Giles	82	197	.43	.16	
May 23 [b]	do	82	204	.45	.16	
August 8 [a]	do	152	1,225	.94	1.27	
August 8 [b]	do	178	496	2.28	1.25	
October 24 [e]	do	90	74	.32	− .04	

[a] Drennan bridge.
[b] Frisco System Railroad bridge.
[c] Boat below Frisco bridge.
[d] Wading, one-third mile below Drennan Bridge.
[e] Wading, one-half mile below Drennan Bridge.

'aily gage height, in feet, of Black Warrior River (Locust Fork) at Palos, Ala., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	0.2	0.6	0.7	1.2	0.7	0.7	1.4	0.4	0.3	0.0	0.0	0.2
.....	.2	.6	.7	1.2	.7	.8	.9	.4	.3	.0	.0	.3
.....	.2	.5	.6	1.1	.6	.7	.5	.7	.3	.0	.2	.4
.....	.1	.5	.6	1.1	.6	.5	.7	.6	.2	.0	.4	.6
.....	.1	.5	.6	1.0	.5	.4	.5	1.0	.2	.0	.4	.1
.....	.1	.5	.6	.9	.5	.4	.3	1.4	.2	.0	.3	1.4
.....	.1	.6	1.9	1.2	.4	.3	.6	1.6	.2	.4	.2	1.3
.....	.1	1.1	2.2	2.1	.7	.3	2.1	1.3	.1	.3	.2	1.1
.....	.1	1.6	1.9	2.5	.7	.3	1.3	1.0	.1	.2	.2	1.9
.....	.2	1.4	1.5	2.1	.6	.2	1.0	.8	.1	.1	.1	.9
.....	.2	1.5	1.3	1.7	.7	.2	.8	1.3	.1	.1	.1	.8
.....	.2	1.3	1.3	1.4	.6	.2	1.1	2.5	.1	.0	.1	.7
.....	.2	1.3	1.3	1.3	.5	.2	1.2	2.1	.1	.0	.1	.7
.....	.2	1.2	2.2	1.1	.4	.1	1.2	1.6	.0	.0	.1	.7
.....	.2	1.0	5.0	1.0	.4	.1	.8	1.2	.0	.0	.1	.6
.....	.2	.8	2.9	.9	.3	.1	.6	1.0	.0	.0	.1	.6
.....	.3	.8	2.0	.9	.3	.0	.5	1.3	.0	.0	.1	.6
.....	.4	.7	1.7	.9	.3	.0	.4	.9	.0	.0	.1	.5
.....	.4	.7	1.5	.9	.2	.0	.4	.8	.0	.0	.1	.5
.....	.4	.8	1.3	.8	.2	.0	.3	.6	.0	.0	.1	.5
.....	.4	.8	1.2	.8	.2	.0	.3	.5	.0	.0	.1	.5
.....	.6	.9	1.1	.8	.2	.0	.2	.4	.0	.0	.1	.4
.....	1.3	.9	1.1	.8	.2	.0	.4	.4	.0	.0	.3	.4
.....	2.3	.9	1.5	.7	.2	.0	.3	.4	.0	.0	.3	.4
.....	1.1	.9	1.5	.7	.2	.6	.3	.3	.0	.0	.2	.8
.....	.9	.8	1.3	.8	.2	.4	.3	.3	.0	.0	.2	.9
.....	.8	.8	1.4	1.2	.1	.2	.4	1.0	.0	.0	.2	1.1
.....	.7	.8	1.7	1.1	.1	.1	.4	.7	.0	.0	.2	2.9
.....	.7	.7	1.6	.9	.1	.4	.5	1.0	.0	.0	.2	2.5
.....	.6	.....	1.4	.8	.2	1.8	.3	.7	.0	.0	.2	1.7
.....	.6	.....	1.3	.....	.5	.....	.2	.5	.....	.0	.....	1.3

ible for Black Warrior River (Locust Fork) at Palos, Ala., from January 1 to December 1, 1904.

Discharge.	Gage height	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet*	*Second-feet*	*Feet*	*Second-feet.*	*Feet.*	*Second-feet.*
34	0.90	690	1.80	2,020	3.40	4,940
67	1.00	810	1.90	2,190	3.60	5,320
110	1.10	935	2.00	2,360	3.80	5,700
165	1.20	1,070	2.20	2,710	4.00	6,100
230	1.30	1,210	2.40	3,070	4.20	6,500
305	1.40	1,360	2.60	3,430	4.40	6,900
390	1.50	1,515	2.80	3,800	4.60	7,300
480	1.60	1,680	3.00	4,180	4.80	7,700
580	1.70	1,850	3.20	4,560	5.00	8,100

bove table is based upon twenty-one discharge measurements made during 03, and 1904. *It is well defined* between gage heights -0.1 foot and 5 feet.

Estimated monthly discharge of Black Warrior River (Locust Fork) at Palos, Ala., for 1904.

[Drainage area, 1,020 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	2,890	67	356	0.349	0.402
February	1,680	305	705	.691	.745
March	8,100	390	1,649	1.62	1.87
April	3,250	480	1,032	1.01	1.13
May	480	67	244	.239	.276
June	2,020	34	225	.221	.247
July	2,530	110	511	.501	.578
August	3,250	165	818	.802	.925
September	165	34	63.8	.063	.070
October	230	34	49.1	.048	.055
November	230	34	99.8	.098	.109
December	3,990	67	805	.789	.910
The year	8,100	34	546	.536	7.32

MISCELLANEOUS MEASUREMENTS IN MOBILE RIVER DRAINAGE BASIN.

The following is a list of miscellaneous discharge measurements made in Mobile River drainage basin during 1904:

Pinelog Creek near Cash, Ga.—This stream flows into Sallacoa Creek, a tributary of Coosawattee River. A measurement was made May 5 at Butler's bridge, about 1 mile above the mouth, near Cash. The bench mark is the top of the downstream end of the cross timber on first bent from the left bank, 17.00 feet above the datum of the gage.

Width, 54 feet; area, 150 square feet; mean velocity, 0.27 foot per second; gage height, 2.80 feet; discharge, 41 second-feet.

Sallacoa Creek near Cash, Ga.—This stream is a tributary of Coosawattee River. A measurement was made May 5 at Covington's bridge, about 4 miles above the mouth of Pinelog Creek and 4 miles east of Cash, Ga. The bench mark is the upstream end of the top of cross timber over the first bent from the left bank, 16.00 feet above the datum of the gage.

Width, 42 feet; area, 164 square feet; mean velocity, 0.15 foot per second; gage height, 2.60 feet; discharge, 24 second-feet.

Jack River near Alaculsy, Ga.—A measurement was made October 5 just above the falls, about 5 miles above the mouth of the river and 23 miles from Blue Ridge, Ga.

Width, 7 feet; area, 7 square feet; mean velocity, 1.86 feet per second; discharge, 13 second-feet.

Oothcaloga Creek near Calhoun, Ga.—This stream is a tributary of ostanaula River. A measurement was made May 6 at a bridge about mile from the mouth of the creek and 1 mile west of Calhoun. The ›nch mark is the downstream end of the top of cross timber on iddle bent, 16.00 feet above the datum of the gage.

Width, 45 feet; area, 50 square feet; mean velocity, 0.64 foot per second; gage ›ight, 2.15 feet; discharge, 32 second-feet.

Connasauga River near Resaca, Ga.—This stream is a tributary of ostanaula River. A measurement was made November 25 from a ›at at Fite's ferry, 2 miles from Resaca, Ga. The bench mark is a nall nail in a large leaning willow tree on the left bank, about 200 et below the ferry, 5.00 feet above the datum of the gage.

Width, 130 feet; area, 219 square feet; mean velocity, 0.74 foot per second; gage ›ight, 2.65 feet; discharge, 163 second-feet.

Etowah River near Kingston, Ga.—Measurements were made at ardin's bridge, 4 miles south of Kingston, Ga., as follows:

January 24: Width, 188 feet; area, 1,178 square feet; mean velocity, 1.60 feet per ›ond; gage height, 3.45 feet; discharge, 1,894 second-feet.
April 14: Width, 188 feet; area, 1,154 square feet; mean velocity, 1.21 feet per ›ond; gage height, 3.27 feet; discharge, 1,401 second-feet.
July 29: Width, 185 feet; area, 1,007 square feet; mean velocity, 0.62 foot per ›ond; gage height, 2.56 feet; discharge, 625 second-feet.

A 5-foot section of gage rod is fastened to a tree on the left bank.

Etowah River near Canton, Ga.—A measurement was made July 27 Field's bridge, about 6 miles below Canton. The bench mark is a ›isel cut and white paint mark at intermediate post, the second floor ›am of the main span from the left end of the bridge, downstream le, 36.00 feet above the datum of the gage.

Width, 89 feet; area, 307 square feet; mean velocity, 1.05 feet per second; gage ›ight, 2.67 feet; discharge, 322 second-feet.

Cave Spring at Cavespring, Ga.—This spring is tributary to Little ›dar Creek. A measurement was made January 21 at the footbridge Cave Spring. The water surface was 16½ inches below the upstream de of the bridge floor, 6 inches from the right end of the bridge.

Width, 13 feet; area, 5.6 square feet; mean velocity, 0.94 foot per second; discharge, 3 second-feet.

Little Cedar River near Cavespring, Ga.—This stream enters Big edar Creek about 2 miles north of Cavespring, Ga. A measurement as made September 28 from the bridge near Cavespring. The bench ark is the top of the first floor beam from the right bank, downstream ıd, 9.00 feet above the datum of the gage.

Width, 30 feet; area, 18 square feet; mean velocity, 1.00 foot per second; gage ›ight, 1.27 feet; discharge, 18 second-feet.

Big Cedar Creek near Cavespring, Ga.—This stream enters Coosa River about 6 miles northwest of Cavespring. Measurements were made at the bridge 2½ miles northeast of Cavespring. The bench mark is the top of the second iron floor beam from the right end of the bridge, upstream side, 17.00 feet above the datum of the gage.

January 21: Width, 62 feet; area, 207 square feet; mean velocity, 0.37 foot per second; gage height, 3.13 feet; discharge, 78 second-feet.

September 28: Width, 67 feet; area, 177 square feet; mean velocity, 0.29 foot per second; gage height, 3.00 feet; discharge, 51 second-feet.

Hatchet Creek near Goodwater, Ala.—This stream enters Coosa River about 10 miles east of Clanton, Ala. A measurement was made October 17 by wading 200 yards below bridge on the road to Hanover, Ala., 8 miles from Goodwater, Ala. The bench mark is the downstream end of the first floor beam from the left bank, 21.00 feet above the datum of the gage.

Width, 26 feet; area, 19 square feet; mean velocity, 0.96 foot per second; gage height, 1.05 feet; discharge, 18 second-feet.

Tallapoosa River near Tallapoosa, Ga.—A measurement was made March 9 from the wooden bridge near the Southern Railway and one-half mile below Bentley's dam, below the mouth of Walkers Creek. The bench mark is the top of the upper end of the floor beam on top of wooden pier, 106 feet from the initial point for soundings, 25.00 feet above the datum of the gage.

Width, 89 feet; area, 517 square feet; mean velocity, 0.74 foot per second; gage height, 6.25 feet; discharge, 381 second-feet.

Tallapoosa River near Heflin, Ala.—A measurement was made September 23 from Ross's bridge near Heflin, Ala. The bench mark is three tacks in first beam from the left bank, downstream side, 17.00 feet above the datum of the gage.

Width, 90 feet; area, 245 square feet; mean velocity, 0.77 foot per second; gage height, 2.22 feet, discharge, 189 second-feet.

Cedar Creek near Wedowee, Ala.—A measurement was made September 24 at the bridge 12 miles north of Wedowee. The bench mark is bolt which holds the bridge to maple tree on the left bank, upstream side, 7.00 feet above the datum of the gage.

Width, 25 feet; area, 42 square feet; mean velocity, 0.53 foot per second; gage height, 1.25 feet; discharge, 22 second-feet.

Hillabee Creek near Alexander City, Ala.—A gaging station was for a while maintained on this tributary of Tallapoosa River; the gage height below is from the old gage. A measurement made October 14 gave the following results:

Width, 87 feet; area, 96 square feet; mean velocity, 0.53 foot per second; gage height, 0.73 foot; discharge, 51 second-feet.

Tallapoosa River at Milstead, Ala.—A measurement was made April 4 at the old gaging station on Tallapoosa River at Milstead, which was abandoned April 30, 1903.

Width, 230 feet; area, 1,587 square feet; mean velocity, 2.44 feet per second; gage height, 2.93 feet; discharge, 3,871 second-feet.

Blackwater Creek near Jasper, Ala.—This stream is a tributary of Mulberry Fork of Black Warrior River. A measurement was made May 24 from the wagon bridge about 5 miles below Carmack's mill, near Jasper, Ala. The bench mark is the top of the downstream end of the floor beam 34 feet from the initial point for soundings, 36.00 feet above the datum of the gage.

Width, 34 feet; area, 41 square feet; mean velocity, 0.42 foot per second; gage height, 1.40 feet, discharge, 17 second-feet.

East Cahaba River near Birmingham, Ala.—A measurement was made August 6 from the foot log at the ford on the road to Columbiana, 10 miles from Birmingham. The bench mark is two copper nails in the downstream side of an ash tree on the left bank, 50 feet below the ford, 8.00 feet above the datum of the gage.

Width, 34 feet; area, 40 square feet; mean velocity, 1.67 feet per second; gage height, 2.00 feet; discharge, 66 second-feet.

East Cahaba River near Bridgeton, Ala.—A measurement was made August 6 at the ford below Deshazo's mill near Bridgeton.

Width, 49 feet; area, 57 square feet; mean velocity, 1.37 feet per second; discharge, 79 second-feet.

PEARL RIVER DRAINAGE BASIN.

Pearl River rises in the eastern part of Mississippi. It flows south into Lake Borgne, an arm of the Gulf of Mexico, forming part of the boundary between Louisiana and Mississippi. The United States Geological Survey maintains one station on this river. It is located at Jackson, Miss.

PEARL RIVER AT JACKSON, MISS.

This station was established June 24, 1901, by K. T. Thomas. It is located 2 miles from the Union station at Jackson, Miss., one-eighth mile above the Alabama and Vicksburg Railroad, and two blocks east from the end of the South State street car line. The chain gage is fastened to the downstream side of the bridge at a point 130 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 41.91 feet. The gage is read once each day by James Hurst. Discharge measurements are made from the single-span highway bridge and from an approach of 680 feet of iron trestle on the left bank. The initial point for soundings is the end of

the bridge on the right bank. The channel makes a 90° curve about 200 feet above the bridge. It is nearly straight for about one-fourth mile below the bridge. The right bank is high and rocky and does not overflow. The left bank is of cleared ground and overflows at about 20 feet gage height. The width of the stream at low stages is about 130 feet and at flood stages about 900 feet. The bed is of sand and gravel and is shifting. The current velocity is moderate, but is not well distributed, and is broken by an old pier and some short piles under the bridge. At low stages the discharge can be measured by wading about one-fourth mile above the bridge. The bench mark is the downstream end of the top of the iron floor beam, 120 feet from the right-bank end of the bridge. Its elevation is 39.00 feet above gage datum. The elevation of the bridge floor at the same point is 40.15 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Pearl River at Jackson, Miss., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Square feet.*	*Feet per sec.*	*Feet.*	*Second-feet.*
March 10	J. M. Giles		7,581	2.11	24.00	16,050
July 13	do		645	2.09	4.15	1,348
July 14	do		826	2.40	5.37	1,988
September 24	do		276	.46	.80	128
September 24	do		267	.53	.78	142
1904.						
January 15	J. M. Giles	107	408	.88	1.82	359
February 26	J. M. Giles and E. C. Murphy.	114	529	1.26	2.49	666
August 12	J. M. Giles	148	1,398	2.48	8.20	3,463
August 12	do	148	1,281	2.82	8.26	3,617
October 28	do	65	238	.35	.30	84
October 28[a]	do	35	72	1.12	.30	73

[a] From boat at different section.

Mean daily gage height, in feet, of Pearl River at Jackson, Miss., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.3	2.0	2.2	8.3	2.0	1.0	2.0	4.4	2.3	1.6	0.3	0.9
.....	1.3	1.9	2.2	8.0	1.9	1.0	1.8	4.2	2.1	1.5	.3	1.0
.....	1.4	1.9	2.3	7.6	1.8	1.0	1.4	3.8	2.0	1.3	.5	.8
.....	1.4	2.0	2.2	6.4	1.8	1.0	1.3	3.4	1.8	1.2	.5	1.0
.....	1.4	2.1	2.3	6.9	2.0	1.0	1.4	3.0	1.5	1.1	.4	1.0
.....	1.4	2.3	3.9	5.5	2.4	1.1	1.4	2.9	1.5	1.0	.4	1.0
.....	1.4	2.3	4.2	5.4	2.7	1.1	1.5	3.1	1.6	1.0	.5	1.3
.....	1.5	2.4	4.5	9.8	2.9	1.0	2.1	3.2	1.5	.9	.4	1.4
.....	1.5	2.6	4.6	10.9	3.2	1.0	2.0	3.8	1.4	.9	.4	1.4
.....	1.4	4.3	3.9	10.9	3.4	1.1	1.7	5.8	1.4	.8	.5	1.4
.....	1.4	5.5	3.8	11.1	2.9	1.2	2.5	6.8	1.4	.8	.5	1.4
.....	1.5	6.5	3.7	10.2	2.6	1.4	4.4	8.1	1.3	.8	.5	1.5
.....	1.6	7.4	3.6	8.6	2.3	1.5	7.1	7.1	1.3	.7	.5	1.5
.....	1.8	6.5	3.7	8.0	1.9	1.7	4.8	6.6	1.3	.6	.5	1.5
.....	1.8	5.6	3.5	7.5	1.8	1.7	5.0	6.2	1.2	.6	.5	1.4
.....	1.8	5.1	3.2	7.1	1.7	1.6	4.7	5.9	1.1	.5	.5	1.4
.....	1.9	4.6	3.1	6.7	1.6	1.5	4.5	5.7	1.1	.5	.5	1.3
.....	1.8	4.2	2.7	5.0	1.6	1.3	4.1	5.5	1.1	.5	.5	1.3
.....	1.8	3.8	2.6	4.3	1.5	1.3	4.2	5.2	1.0	.5	.5	1.2
.....	1.7	3.5	2.7	3.7	1.5	1.2	5.2	4.9	1.0	.4	.5	1.2
.....	1.7	3.2	7.3	3.5	1.4	1.2	4.9	4.6	1.0	.4	.7	1.1
.....	1.8	3.0	6.7	3.1	1.3	1.1	3.8	4.4	1.0	.4	.8	1.1
.....	2.0	2.8	7.0	2.9	1.2	1.1	3.6	4.2	1.0	.4	.7	1.0
.....	1.9	2.6	6.7	2.8	1.2	1.1	3.1	3.8	1.3	.4	.6	1.0
.....	1.7	2.5	6.2	2.6	1.2	.9	2.8	3.6	1.4	.4	.6	1.0
.....	1.7	2.5	5.6	2.4	1.1	.8	2.7	3.3	1.2	.3	.6	1.1
.....	1.8	2.4	6.8	2.3	1.1	.8	2.6	2.9	1.2	.3	.5	1.7
.....	1.9	2.3	9.4	2.2	1.1	.8	2.6	2.8	1.3	.3	.5	1.9
.....	2.0	2.2	9.9	2.1	1.1	1.2	2.7	2.7	1.4	.3	.6	1.5
.....	2.0	.....	9.5	2.0	1.1	3.6	4.0	2.9	1.6	.3	.8	1.8
.....	2.0	.....	8.7	.....	1.1	.....	4.5	2.7	.....	.3	.....	2.4

Rating table for Pearl River at Jackson, Miss., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	80	1.50	262	3.40	982	5.80	2,200
.40	88	1.60	288	3.60	1,078	6.00	2,310
.50	97	1.70	316	3.80	1,174	6.50	2,585
.60	108	1.80	345	4.00	1,272	7.00	2,860
.70	120	1.90	375	4.20	1,370	7.50	3,135
.80	133	2.00	407	4.40	1,470	8.00	3,435
.90	147	2.20	475	4.60	1,570	8.50	3,735
1.00	162	2.40	548	4.80	1,670	9.00	4,035
1.10	178	2.60	627	5.00	1,770	9.50	4,335
1.20	196	2.80	710	5.20	1,870	10.00	4,635
1.30	216	3.00	797	5.40	1,980	10.50	4,935
1.40	238	3.20	888	5.60	2,090	11.00	5,235

The preceding table is based upon fourteen discharge measurements made during 1901-1904. It is well defined between gage heights 0.30 foot and 8.30 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Pearl River at Jackson, Miss., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	407	216	310
February	3,080	375	1,050
March	4,575	475	1,747
April	5,295	407	2,372
May	982	178	382
June	1,078	133	224
July	2,915	216	972
August	3,495	668	1,518
September	511	162	242
October	288	80	125
November	133	80	100
December	548	133	222
The year	5,295	80	773

MINOR EASTERN GULF OF MEXICO DRAINAGE BASINS.

MISCELLANEOUS MEASUREMENTS.

Conecuh River near River Falls, Ala.—A measurement was made May 24 at a bridge 8 miles above the regular gaging station on Conecuh River at Beck, Ala. The water surface was 46.69 feet below the top of the downstream end of second floor beam from the left end of the bridge.

Width, 120 feet; area, 372 square feet; mean velocity, 1.05 feet per second; discharge, 391 second-feet.

Patsaliga Creek near Gantt, Ala.—This stream is practically the North Fork of Conecuh River, entering from the right about 4 miles north of Andalusia, Ala. A measurement was made June 24 at Parker Bridge, near Gantt. The water surface was 28.07 feet below the head of a nail driven into the top of the downstream end of the wooden floor beam under the middle of the truss.

Width, 65 feet; area, 48 square feet; mean velocity, 1.89 feet per second; discharge, 91 second-feet.

Yellow River near Oak Grove, Fla.—A measurement was made June 23 at Richburg Bridge, about 7 miles east of Laurel Hill, Fla. The bench mark is the top of the upstream end of the first floor beam from the left pier of the bridge, 20.00 feet above the datum of the gage.

Width, 107 feet; area, 190 square feet; mean velocity, 1.20 feet per second; gage height, 2.19 feet; discharge, 227 second-feet.

Choctawhatchee River near Elba Junction, Ala.—A measurement as made September 24 from the Atlantic Coast Line Railway bridge, ear Elba Junction. The water surface was 35.85 feet below the top f the first floor beam from the right bank.

Width, 95 feet; area, 471 square feet; mean velocity, 0.26 foot per second; discharge, 124 second-feet.

Choctawhatchee River near Newton, Ala.—A measurement was made eptember 24 at the wagon bridge 1 mile west of Newton and 2 miles elow the gaging made the same day near Elba Junction. The water urface was 36.70 feet below the top of reinforcing plate at the bottom f the fourth intermediate post from the left bank, downstream side.

Width, 55 feet; area, 99 square feet; mean velocity, 1.27 feet per second; discharge, 25 second-feet.

Choctawhatchee River near Bellwood, Ala.—A measurement was made June 20 from the wagon bridge 2 miles from Bellwood. The water surface was 20.45 feet below the top of the downstream lower chord, at a point 1 foot to the right of the first intermediate post from the left bank.

Width, 151 feet; area, 456 square feet; mean velocity, 0.90 foot per second; discharge, 411 second-feet.

Suwanee River at railway bridge, near Suwanee, Fla.—Measurements were made from the Atlantic Coast Line Railway bridge near Suwanee, Fla. The bench mark is the top of the downstream end of the second floor beam from the right bank, 45.00 feet above the datum of the gage.

December 20—Width, 79 feet; area, 397 square feet; mean velocity, 0.74 foot per second; gage height, 2.85 feet; discharge, 295 second-feet.

December 20—Width, 79 feet; area, 394 square feet; mean velocity, 0.73 foot per second; gage height, 2.85 feet; discharge, 290 second-feet.

Suwanee River at wagon bridge, near Suwanee, Fla.—A measurement was made December 21 from the wagon bridge at Suwanee Sulphur Spring. The bench mark is a chisel mark on the first intermediate post from the right bank, 6 feet above the top of the floor beam, 41.00 feet above the datum of the gage.

Width, 89 feet; area, 249 square feet; mean velocity, 0.95 foot per second; gage height, 1.57 feet; discharge, 237 second-feet.

Suwanee River near Ellaville, Fla.—A measurement was made December 22 from the Seaboard Air Line Railway bridge. The bench mark is the downstream end of the first floor beam from the left bank, 37.00 feet above the datum of the gage.

Width, 231 feet; area, 1,798 square feet; mean velocity, 1.01 feet per second; gage height, 1.41 feet; discharge 1,813 second-feet.

Santa Fe River near High Springs, Fla.—This stream enters Suwanee River from the left about 30 miles above its mouth. A measure-

ment was made December 22 at the wagon bridge, just above the Atlantic Coast Line Railroad bridge. The bench mark is the top of the downstream end of the cap of the first bent from the left bank, 17.00 feet above the datum of the gage.

Width, 130 feet; area, 996 square feet; mean velocity, 0.54 foot per second; gage height, 1.60 feet; discharge, 537 second-feet.

Withlacoochee River at Dunnellon, Fla.—A measurement was made December 24 from the new iron wagon bridge, one-fourth mile from Dunnellon, Fla.:

Width, 82 feet; area, 1,003 square feet; mean velocity, 1.27 feet per second; discharge, 1,270 second-feet. The water surface was 14.05 feet below the top of the downstream right-bank pier.

Blue Run near Dunnellon, Fla.—This stream is tributary to Withlacoochee River. A measurement was made December 24 from the wagon bridge, three-fourths mile east of Dunnellon:

Width, 53 feet; area, 422 square feet; mean velocity, 1.70 feet per second; discharge, 716 second-feet. The water surface was 4.45 feet below the top of the cap of the right bent, downstream side of the bridge.

INDEX.

—	Page.
n	127–128
	128
, monthly	130
ıts	129
le	129
ar:	
n	174
	174
ear:	
n	120
	120
.:	
n	109–111
	111
, monthly	113
ıts	112
le	113
: Creek near:	
n	115–116
	116
ek near:	
n	114–115
	115
r—	
ı.:	
n	69–70
	70
, monthly	72
hts	71
le	71
›ry, Ga.:	
n	89
	89
ıla.	
k near:	
n	176
	176
of the Carolinas) at:	
n	28–29
	29
, monthly	31
hts	30
le	30
lrainage basin:	
	59–60
near—	
ı.:	
n	72–73
	73
, monthly	75

Apalachee River near—Continued.	Page.
Buckhead, Ga.—Continued.	
gage heights	74
rating table	74
Apalachicola River drainage basin:	
description	90–91
Armour, Ga.	
Peachtree Creek at:	
description	118
discharge	118
Peachtree Creek (North Fork) near:	
description	117
discharge	117
Peavine Creek near:	
description	118
discharge	118
Augusta, Ga.	
Savannah River at:	
description	42–43
discharge	43
discharge, monthly	45
gage heights	44
rating table	45
Austell, Ga.	
Sweetwater Creek near:	
description	103, 119
discharge	104, 119
gage heights	104
Beaverdam Creek near—	
Clarksville, Ga.:	
description	116
discharge	116
Greensboro, Ga.:	
description	89–90
discharge	90
Beck, Ala.	
Conecuh River at:	
description	125–126
discharge	126
gage heights	127
Bellwood, Ala.	
Choctawhatchee River near:	
description	181
discharge	181
Belmont, N. C.	
Catawba River near:	
description	36
discharge	36
Catawba River (South Fork) near:	
description	36
discharge	36
Big Cedar Creek near—	
Cavespring, Ga.:	
description	176
discharge	176

Page.
Big Potato Creek near—
Thomaston, Ga.:
description 114, 120
discharge 114, 120
Birmingham, Ala.
East Cahaba River near:
description 177
discharge 177
Black Warrior River at and near—
Cordova, Ala.:
description 163-164
discharge 164
discharge, monthly 166
gage heights 165
rating table 166
Tuscaloosa, Ala.:
description 167
discharge 168
gage heights 168
Black Warrior River (Locust Fork) at—
Palos, Ala.:
description 171-172
discharge 172
discharge, monthly 174
gage heights 173
rating table 173
Black Water Creek near—
Jasper, Ala.:
description 170, 177
discharge 171, 177
Blackshear, Ga.
Hurricane Creek near:
description 90
discharge 90
Blue Run near—
Dunnellon, Fla.:
description 182
discharge 182
Blue Spring near—
Albany, Ga.:
description 120
discharge 120
Bridgeton, Ala.
East Cahaba River near:
description 177
discharge 177
Broad River (of the Carolinas) at—
Alston, S. C.:
description 28-29
discharge 29
discharge, monthly 31
gage heights 30
rating table 30
Broad River (of Georgia) near—
Carlton, Ga.:
description 50
discharge 51
discharge, monthly 52
gage heights 51
rating table 52
Broad River (South Fork) near—
Carlton, Ga.:
description 53, 54
discharge 53, 54
Comer, Ga.:
description 53
discharge 53

Page.
Brookwood, Ga.
Peachtree Creek near:
description 118
discharge 118
Buckhead, Ga.
Apalachee River near:
description 72-73
discharge 73
discharge, monthly 75
gage heights 74
rating table 74
Cahaba River at—
Centerville, Ala.:
description 157-158
discharge 158
discharge, monthly 160
gage heights 159
rating table 159
Calhoun, Ga.
Oothcaloga Creek near:
description 175
discharge 175
Calhoun, S. C.
Keowee River near:
description 53
discharge 53
Calhoun Falls, Ga.
Rocky River near:
description 49-50
discharge 50
Camden, S. C.
Wateree River near:
description 27-28
discharge 28
gage heights 29
Cannoochee River near—
Groveland, Ga.:
description 56-57
discharge 57
discharge, monthly 59
gage heights 58
rating table 58
Canton, Ga.
Etowah River at and near:
description 130-131, 175
discharge 131, 175
discharge, monthly 133
gage heights 132
rating table 132
Carlton, Ga.
Broad River (of Georgia) near:
description 50
discharge 51
discharge, monthly 52
gage heights 51
rating table 52
Broad River (South Fork) near:
description 53, 54
discharge 53, 54
Clouds Creek near:
description 54
discharge 54
Cartecay, Ga.
Cartecay River near:
description 142
discharge 142
gage heights 143

ear—	Page.
.:	
on	142
:	142
;hts	143
River at:	
on	139
:	140
:, monthly	141
'hts	140
ble	141
ε Creek near:	
on	144–145
'	145
k near:	
on	174
'	174
'k near:	
on	174
'	174
er near:	
on	20
'	21
', monthly	22
hts	21
ble	22
ear—	
?.:	
on	36
	36
'.:	
on	20
	21
, monthly	22
hts	21
ble	22
;. C.:	
on	23
	24
, monthly	26
hts	25
ble	25
C.:	
n	36
	36
South Fork) near—	
:.:	
n	36
	36
a.:	
n	175
	175
'ek near	
n	176
	176
t:	
n	175
	175
'reek near:	
n	175
	175

Cedar Creek near—	Page.
Wedowee, Ala.:	
description	176
discharge	176
Centerville, Ala.	
Cahaba River at:	
description	157–158
discharge	158
discharge, monthly	160
gage heights	159
rating table	159
Chattahoochee River at and near—	
Cornelia, Ga.:	
description	91–92
discharge	92
Norcross, Ga.:	
description	92–93
discharge	93
discharge, monthly	95
gage heights	94
rating table	94
Oakdale, Ga.:	
description	95–96
discharge	96
discharge, monthly	98
gage heights	97
rating table	97
West Point, Ga.:	
description	98–99
discharge	99
discharge, monthly	101
gage heights	100
rating table	100
Chauga River near—	
Fort Madison, S. C.:	
description	46
discharge	46
Choccolocco Creek near—	
Jenifer, Ga.:	
description	145
discharge	146
discharge, monthly	148
gage heights	147
rating table	147
Choctawhatchee River near—	
Bellwood, Ala.:	
description	181
discharge	181
Elba Junction, Ala.:	
description	181
discharge	181
Geneva, Ala.:	
description	121
discharge	122
gage heights	122
Newton, Ala.:	
description	181
discharge	181
Choctawhatchee River drainage basin:	
description	120–121
Clarksville, Ga.	
Beaverdam Creek near:	
description	116
discharge	116
Deep Creek near:	
description	116
discharge	116

Clarksville, Ga.—Continued. Page.
Soque River near:
description 117
discharge 117
Clear Creek near—
Elk, Ala.:
description 169
discharge 169
gage heights 170
Clemson College, S. C.
Seneca River near:
description 46–47
discharge 47–48
discharge, monthly 49
gage heights 48
rating table 49
Clouds Creek near—
Carlton, Ga.:
description 54
discharge 54
Columbus, Ga.
Mulberry Creek near:
description 105
discharge 105
Columbus, Miss.
Tombigbee River near:
description 160–161
discharge 161
discharge, monthly 163
gage heights 162
rating table 162
Comer, Ga.
Broad River of Georgia (South Fork) near:
description 53
discharge 53
Concord, Ga.
Flint River near:
description 119
discharge 119
Conecuh River at and near—
Beck, Ala.:
description 125–126
discharge 126
gage heights 127
River Falls, Ala.:
description 180
discharge 180
Connasauga River near—
Resaca, Ga.:
description 175
discharge 175
Coosa River at—
Riverside, Ala.:
description 136
discharge 136
discharge, monthly 138
gage heights 137
rating table 137
Coosawattee River at—
Carters, Ga.:
description 139
discharge 140
discharge, monthly 141
gage heights 140
rating table 141
Cordova, Ala.
Black Warrior River near:
description 163–164
Cordova, Ala.—Continued. Page.
Black Warrior River near—Cont'd.
discharge 164
discharge, monthly 166
gage heights 165
rating table 166
Cornelia, Ga.
Chattahoochee River near:
description 91–92
discharge 92
Soque River near:
description 117
discharge 117
Covington, Ga.
Alcovy River near:
description 69–70
discharge 70
discharge, monthly 72
gage heights 71
rating table 71
Davisboro, Ga.
Williamsons Swamp Creek at:
description 54–55
discharge 55
gage heights 55
Deep Creek near—
Clarksville, Ga.:
description 116
discharge 116
Delta, S. C.
Tiger River at:
description 31
discharge 31
Demorest, Ga.
Hazel Creek near:
description 117
discharge 117
Soque River near:
description 101–102
discharge 102
discharge, monthly 103
gage heights 102
rating table 102
Double Bridges Creek at—
Geneva, Ala.:
description 122–123
discharge 123
gage heights 123
Dublin, Ga.
Oconee River at:
description 81–82
discharge 83
discharge, monthly 85
gage heights 84
rating table 84
Dunnellon, Fla.
Blue Run near:
description 182
discharge 182
Withlacoochee River at:
description 182
discharge 182
East Cahaba River near—
Birmingham, Ala.:
description 177
discharge 177
Bridgeton, Ala.:
description 177
discharge 177

Ala. Page.
tchee River near:
tion 181
ge..... 181

: near:
tion 169
ge..... 169
ights..... 170

iver near:
:ion 181
ge..... 181

er near:
ion 143
ge..... 144
wn Creek near:
ion 144
ge..... 144
ear—
:
ion 143
ge..... 144
ear—
3. C.:
ion 32
ge..... 32
drainage basin:
..... 125
t and near—
:
ion 130–131, 175
ge..... 131, 175
ge, monthly..... 133
ights..... 132
able 132
a.:
ion 175
ge..... 175

ion 133–134
ge..... 134
ge, monthly..... 135
ights..... 135
able 135
nd near—
:
ion 109–111
ge..... 111
ge, monthly..... 113
ights..... 112
able 113
.:
ion 119
ge..... 119
, Ga.:
ion 119
ge..... 119
Ga.:
ion 105–106, 119
ge..... 106, 119
ge, monthly..... 109
ghts..... 107
able 108

Flovilla, Ga. Page.
Ocmulgee River near:
description 63–64
discharge..... 64
discharge, monthly..... 66
gage heights..... 65
rating table 65
Fort Madison, S. C.
Chauga River near:
description 46
discharge..... 46
Gantt, Ala.
Patsaliga Creek near:
description 180
discharge..... 180
Geneva, Ala.
Choctawhatchee River near:
description 121
discharge..... 122
gage heights..... 122
Double Bridges Creek at:
description 122–123
discharge..... 123
gage heights..... 123
Goodwater, Ala.
Hatchet Creek near:
description 176
discharge..... 176
Greensboro, Ga.
Beaverdam Creek near:
discription..... 89–90
discharge..... 90
Oconee River near:
description 75–76
discharge..... 76
discharge, monthly 78
gage heights 77
rating table 77
Groveland, Ga.
Cannoochee River near:
description 56–57
discharge..... 57
discharge, monthly 59
gage heights..... 58
rating table 58
Hatchet Creek near—
Goodwater, Ala.:
description 176
discharge..... 176
Hazel Creek near—
Demorest, Ga.:
description 117
discharge..... 117
Heflin, Ala.
Tallapoosa River near:
description 152, 176
discharge..... 152, 176
High Springs, Fla.
Santa Fe River near:
description 181–182
discharge..... 182
Hillabee Creek near—
Alexander City, Ala.:
description 176
discharge..... 176

Page.

Horse Creek near—
Lumber City, Ga.:
description 89
discharge 89
Hurricane Creek near—
Blackshear, Ga.:
description 90
discharge 90
Jack River near—
Alaculsy, Ga.:
description 174
discharge 174
Jackson, Ga.
South River near:
description 88
discharge 88
Yellow River near:
description 88
discharge 88
Jackson, Miss.
Pearl River at:
description 177-178
discharge 178
discharge, monthly 180
gage heights 179
rating table 179
Jasper, Ala.
Black Water Creek near:
description 170, 177
discharge 171, 177
Jenifer, Ga.
Choccolocco Creek near:
description 145
discharge 146
discharge, monthly 148
gage heights 147
rating table 147
John River near—
Morganton, N. C.:
description 26
discharge 27
Keowee River near—
Calhoun, S. C.:
description 53
discharge 53
Kinchafoonee Creek near—
Albany, Ga.:
description 115-116
discharge 116
Kingston, Ga.
Etowah River near:
description 175
discharge 175
Lithia Springs, Ga.
Sweetwater Creek near:
description 118
discharge 118
Lithonia, Ga.
Pole Bridge Creek near:
description 88
discharge 88, 89
South River near:
description 60, 61
discharge 61
discharge, monthly 63
gage heights 62
rating table 62

Page.

Little Cedar Creek near—
Cavespring, Ga.:
description 175
discharge 175
Little Ocmulgee River at—
Wilcox, Ga.:
description 89
discharge 89
Little River near—
Milledgeville, Ga.:
description 90
discharge 90
Little Tallapoosa River near—
Wedowee, Ala.:
description 156, 157
discharge 157
Lumber City, Ga.
Horse Creek near:
description 89
discharge 89
Macon, Ga.
Ocmulgee River at:
description 66-67
discharge 67
discharge, monthly 69
gage heights 68
rating table 68
Madison, S. C.
Tugaloo River near:
description 39-40
discharge 40
discharge, monthly 42
gage heights 41
rating table 41
Milledgeville, Ga.
Little River near:
description 90
discharge 90
Oconee River at and near:
description 78-79, 89
discharge 79, 89
discharge, monthly 81
gage heights 80
rating table 80
Milstead, Ala.
Tallapoosa River at:
description 177
discharge 177
Mobile River drainage basin:
description 12
Montezuma, Ga.
Flint River near:
description 11
discharge 11
Morganton, N. C.
Catawba River near:
description .....
discharge .....
discharge, monthly .....
gage heights .....
rating table .....
John River near:
description .....
discharge .....
Mountaintown Creek near—
Ellijay, Ga.:
description .....
discharge .....

	Page.
..	114-115
	115
.	
	105
	105
iver near:	
	181
	181
:	
	89
	89
ear:	
	118
	118
—	
	118
	118
er near:	
	92-93
	93
ıthly	95
	94
	94
::	
	148
	149
ıthly	150
	149
	150
:	
	180
	180
er at:	
	95-96
	96
ıthly	98
	97
	97
d near—	
	63-64
	64
ıthly	66
	65
	65
	66-67
	67
ıthly	69
	68
	68
ıear—	
	81-82
	83
ıthly	85

	Page.
Oconee River at and near—Continued.	
Dublin, Ga.—Continued.	
gage heights	84
rating table	84
Greensboro, Ga.:	
description	75-76
discharge	76
discharge, monthly	78
gage heights	77
rating table	77
Milledgeville, Ga.:	
description	78-79, 89
discharge	79-89
discharge, monthly	81
gage heights	80
rating table	80
Ogeechee River drainage basin:	
description	54
Ohopee River near—	
Reidsville, Ga.:	
description	85-86
discharge	86
discharge, monthly	88
gage heights	87
rating table	87
Oostanaula River at—	
Resaca, Ga.:	
description	138-139
Oothcaloga Creek near—	
Calhoun, Ga.:	
description	175
discharge	175
Palos, Ala.	
Black Warrior River (Locust Fork) at:	
description	171-172
discharge	172
discharge, monthly	174
gage heights	173
rating table	173
Patsaliga Creek near—	
Gantt, Ala.:	
description	180
discharge	180
Pea River at—	
Pera, Ala.:	
description	123-124
discharge	124
gage heights	125
Peachtree Creek at and near—	
Armour, Ga.:	
description	118
discharge	118
Brookwood, Ga.:	
description	118
discharge	118
Peachtree Creek (North Fork) near—	
Armour, Ga.:	
description	117
discharge	117
Pearl River at—	
Jackson, Miss.:	
description	177-178
discharge	178
discharge, monthly	180
gage heights	179
rating table	179
Pearl River drainage basin:	
description	XII

Page.
Peavine Creek near—
Armour, Ga.:
description 118
discharge 118
Pera, Ala.
Pea River at:
description 123-124
discharge 124
gage heights 125
Pinelog Creek near—
Cash, Ga.:
description 174
discharge 174
Pole Bridge Creek near—
Lithonia, Ga.:
description 88
discharge 88, 89
Red Oak Creek near—
Woodbury, Ga.:
description 119-120
discharge 120
Reedy River near—
Waterloo, S. C.:
description 35
discharge 36
Reidsville, Ga.
Ohoopee River near:
description 85-86
discharge 86
discharge, monthly 88
gage heights 87
rating table 87
Resaca, Ga.
Connasauga River near:
description 175
discharge 175
Oostanaula River at:
description 138-139
River Falls, Ala.
Conecuh River near:
description 180
discharge 180
Riverside, Ga.
Coosa River at:
description 136
discharge 136
discharge, monthly 138
gage heights 137
rating table 137
Riverview, Ga.
White Oak Creek near:
description 119
discharge 119
Rock Hill, N. C.
Catawba River near:
description 36
discharge 36
Rocky River near—
Calhoun Falls, S. C.:
description 49-50
discharge 50
Rome, Ga.
Etowah River near:
description 133-134
discharge 134
discharge, monthly 135
gage heights 135
rating table 135

Page.
Rottenwood Creek near—
Vinings, Ga.:
description 117
discharge 117
Sallacoa Creek near—
Cash, Ga.:
description 174
discharge 174
Saluda River near—
Waterloo, S. C.:
description 32-33, 36
discharge 33, 36
discharge, monthly 35
gage heights 34
rating table 34
Santa Fe River near—
High Springs, Fla.:
description 181-182
discharge 182
Santee River drainage basin:
description 17-19
Satilla River near—
Waycross, Ga.:
description 90
discharge 90
Savannah River at—
Augusta, Ga.:
description 42-43
discharge 43
discharge, monthly 45
gage heights 44
rating table 45
Savannah River drainage basin:
description 37
Selma, Ala.
Alabama River at:
description 127-128
discharge 128
discharge, monthly 130
gage heights 129
rating table 129
Seneca River near—
Clemson College, S. C.:
description 46-47
discharge 47-48
discharge, monthly 49
gage heights 48
rating table 49
Soque River near—
Clarksville, Ga.:
description 117
discharge 117
Cornelia, Ga.:
description 117
discharge 117
Demorest, Ga.:
description 101-102
discharge 102
discharge, monthly 103
gage heights 102
rating table 102
South River near—
Jackson, Ga.:
description 88
discharge 88
Lithonia, Ga.:
description 60, 61
discharge 61

apply and Irrigation Paper No. 128 Series P, Hydrographic Progress Reports, 33

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

GRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

BY

M. R. HALL, E. JOHNSON, Jr., and JOHN C. HOYT

PART V.—Eastern Mississippi River Drainage

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

Page.

Waterloo, S. C.—Continued.
Saluda River near—Continued.
gage heights 34
rating table 34
Waycross, Ga.
atilla River near:
description 90
discharge 90
Wedowee, Ala.
Cedar Creek near:
description 176
discharge 176
Little Tallapoosa River 3 miles north of:
description 156
discharge 157
Little Tallapoosa River 6 miles northwest of:
description 157
discharge 157
West Point, Ga.
Chattahoochee River at:
description 98–99
discharge 99
discharge, monthly 101
gage heights 100
rating table 100
White Oak Creek near—
Riverview, Ga.:
description 119
discharge 119
Warnersville, Ga.:
description 119
discharge 119
Whitmire, S. C.
Enoree River near:
description 32
discharge 32

Page.

Wilcox, Ga.
Little Ocmulgee River at:
description 89
discharge 89
Sugar Creek at:
description 89
discharge 89
Wiley, Ga.
Tiger Creek at:
description 53
discharge 53
Williamsons Swamp Creek at—
Davisboro, Ga.:
description 54–55
discharge 55
gage heights 56
Withlacoochee River at—
Dunnellon, Fla.:
description 182
discharge 182
Woodbury, Ga.
Flint River near:
description 105–106, 119
discharge 106, 119
discharge, monthly 109
gage heights 107
rating table 108
Red Oak Creek near:
description 119–120
discharge 120
Yellow River near—
Jackson, Ga.:
description 88
discharge 88
Oak Grove, Fla.:
description 190
discharge 190

O

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 127.]

he publications of the United States Geological Survey consist of (1) Annua. orts; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral ources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of ted States, folios and separate sheets thereof; (8) Geologic Atlas of United es, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publica- ; the others are distributed free. A circular giving complete lists may be had ıpplication.

lost of the above publications may be obtained or consulted in the following 's:

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ries P.—The hydrographic progress reports contain the results of stream measurements. A rt is issued for every calendar year, containing the results of data collected during that year. e reports were first published as a part of the Director's annual report or as a bulletin; they are published as water-supply and irrigation papers. The following is a list, by years, of the publica- containing the progress reports of stream measurements. A detailed index of these reports -1903) is published as Water-Supply Paper No. 119.

888. Tenth Annual Report, Part II.
889. Eleventh Annual Report, Part II.
890. Twelfth Annual Report, Part II.
891. Thirteenth Annual Report, Part III.
892. Fourteenth Annual Report, Part II.
893. Bulletin No. 131.
894. Bulletin No. 131; Sixteenth Annual Report, Part II.
895. Bulletin No. 140.
896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39; Twenty-first Annual Report, Part IV.
900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV.
901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.

1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124, 125, 126, 127, 128, and 129.
West of Mississippi River, Water-Supply Papers Nos. 130, 131, 132, 133, 134, and 135.

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Correspondence should be addressed to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

JUNE, 1905.

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DEPARTMENT OF THE INTERIOR
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CHARLES D. WALCOTT, DIRECTOR

REPORT

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PART V.—Eastern Mississippi River Drainage

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

CONTENTS.

	Page.
.....	5
.....	7
nowledgments	17
inage basin	18
River near Sauk Rapids, Minn	18
inage basin	20
iver near Eau Claire, Wis	20
iver near Ladysmith, Wis	22
inage basin	25
iver at Merrill, Wis	25
iver near Necedah, Wis	28
basin	31
at Rockton, Ill	31
ge basin	34
r near Minooka, Ill	35
r at Ottawa, Ill	37
r near Peoria, Ill	39
River above Jackson Creek, near Channahon, Ill	40
is measurements	44
inage basin	44
iver at Redhouse, N. Y	45
iver at Kittanning, Pa	47
River at Jamestown, N. Y	48
s River at Salina, Pa	49
reek at Blacklick, Pa	50
drainage basin	51
near Morgantown, W. Va	52
ny River at Friendsville, Md	54
ny River near Confluence, Pa	56
iver at Confluence, Pa	57
Creek at Confluence, Pa	58
inage basin	59
iver at Youngstown, Ohio	60
rainage basin	62
er at Pleasant Valley, Ohio	63
nage basin	65
at Radford, Va	66
at Fayette, W. Va	68
River at Alderson, W. Va	70
e basin	74
near Columbus, Ohio	74
iver near Columbus, Ohio	77
lrainage basin	80
near Springfield, Ohio	80
age basin	82
er at Logansport, Ind	83

Wabash River drainage basin—Continued. Pa
Tippecanoe River near Delphi, Ind
White River (West Branch) at Indianapolis, Ind
Eel River (lower) near Cataract, Ind
White River (East Branch) at Shoals, Ind
Cumberland River drainage basin
Cumberland River at Nashville, Tenn
Tennessee River drainage basin
French Broad River at Horseshoe, N. C
French Broad River at Bingham Bridge near Asheville, N. C
French Broad River at Smith Bridge, near Asheville, N. C 1
French Broad River at Oldtown near Newport, Tenn 1
Swannanoa River at Biltmore, N. C 1
Tennessee River near Knoxville, Tenn 1
Tennessee River at Chattanooga, Tenn 1
Davidsons River near Davidsons River, N. C 1
Avery Creek at Davidsons River, N. C 1
Little River at Calhoun, N. C 1
Mills River (North Fork) at Pinkbed, N. C 1
Mills River (South Fork) near Sitton, N. C 1
Pigeon River at Newport, Tenn 1
Nolichucky River near Greeneville, Tenn 1
Holston River (South Fork) at Bluff City, Tenn 1
Holston River at Austins Mills near Rogersville, Tenn 1
Wautauga River near Elizabethton, Tenn 1
Doe River at Elizabethton, Tenn 1
Little Tennessee River at Judson, N. C 1
Tuckasegee River at Bryson, N. C 1
Hiwassee River at Murphy, N. C 1
Hiwassee River at Reliance, Tenn
Valley River at Tomotla, N. C
Nottely River near Ranger, N. C
Ocoee River at McCays, Tenn
Fightingtown Creek at McCays, Tenn
Paint Rock River near Paintrock, Ala
Flint River at Brownsboro, Ala 1
Elk River near Elkmont, Ala 1
Big Spring at Tuscumbia, Ala 1
Duck River at Columbia, Tenn 1
Miscellaneous measurements 1
Yazoo River drainage basin 1
Yazoo River at Yazoo City, Miss 1
Index 1

ILLUSTRATIONS.

PLATE I. Map showing location of principal gaging stations in the United States
II. Price electric current meters, with buzzers
FIG. 1. Cable station, showing section of the river, car, gage, etc

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., March 2, 1905.

R: I transmit herewith the manuscript of Part V of a series of ve papers which compose the Report of Progress of Stream Meas- ıents for the Calendar Year 1904. Parts I to VI of this report ıin the results of the data collected in the territory east of the issippi River. Parts VII to XII are devoted to the data collected e territory west of the Mississippi River.

ıe larger part of the original data for this report was collected r the direction of district hydrographers M. R. Hall and E. ıson, jr. Mr. Hall covered the territory south of and including ıessee River and was assisted by Warren E. Hall, J. M. Giles, and . Drane. Mr. Johnson had the northern portion of the drainage was assisted by F. W. Hanna and R. W. Pratt. The assembling ıe data and its preparation for publication were done under the :tion of John C. Hoyt, who has been assisted by R. H. Bolster, ert Follansbee, Willis E. Hall, A. H. Horton, H. D. Comstock, I. Tillinghast, and H. M. Morse.

:equest that this manuscript be published as one of the series of er-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

on. CHARLES D. WALCOTT,
Director United States Geological Survey.

)GRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART V.

By M. R. HALL, E. JOHNSON, Jr., and JOHN C. HOYT.

INTRODUCTION.

he hydrographic work of the United States Geological Survey udes the collection of facts concerning and the study of conditions cting the behavior of water from the time it reaches the earth as ı or snow until it joins the oceans or great navigable rivers. These estigations became a distinct feature of the work of the Survey in fall of 1888, when an instruction camp was established at Embudo, Mex. Since that date the work has been continually and gradually ended as larger funds became available. The first distinctive ropriation for gaging streams was made by the act of August 18, 4, which contained an item of $12,500, "for gaging the streams determining the water supply of the United States, including the estigation of underground currents and artesian wells in the arid semiarid sections." (Digest of Appropriations for 1895, p. 270.) ince that time a similar act has been passed each year and the ropriations have gradually increased, as shown in the following e:

Annual appropriations for hydrographic surveys.

ending June 30, 1895	$12,500
ending June 30, 1896	25,000
ending June 30, 1897	50,000
ending June 30, 1898	50,000
ending June 30, 1899	50,000
ending June 30, 1900	50,000
ending June 30, 1901	100,000
ending June 30, 1902	100,000
ending June 30, 1903	200,000
ending June 30, 1904	200,000
ending June 30, 1905	200,000
ending June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observation.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations, and, second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is

MINED DURING 1904.

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observation.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations, and, second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is

ift some appliance, generally a secondary cable, is necessary to ld the meter below the surface.

Gaging stations are generally located at bridges, if the channel con- ions are satisfactory, as from them the meter can be easily manipu- ed, and the cost of the equipment is comparatively small. The tions are located as far as possible at points where the channel is aight, both above and below the gaging section, and where there no cross currents, backwater, or boils. The bed of the stream ould be as clear as possible from large projections and of a perma- nt character. The banks should be high, and should overflow at gh stages only. At stations with shifting beds more measurements e made, and special methods of computing daily discharges are ployed. Great care is taken in the selection and equipment of ging stations in order that the data may have the required degree accuracy.

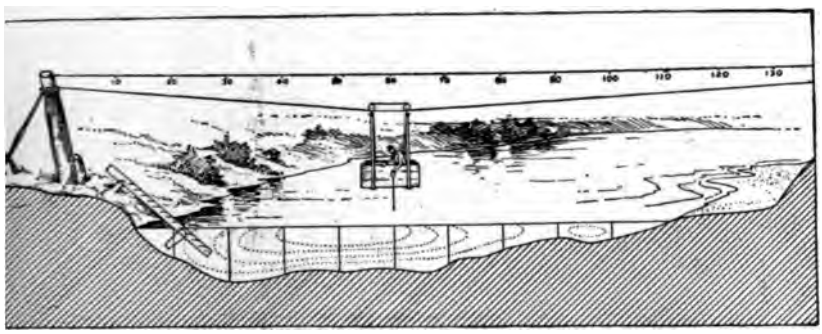

FIG. 1.—Cable station, showing section of river, car, gage, etc.

On many of the larger rivers, where water power is developed by ms, estimates of flow are obtained by observing the head on the est and using a weir formula. On the smaller streams sharp-crested eirs are in some cases erected.

The principal instrument used in stream-measurement work is the rrent meter, by which the velocity of the flow of water is deter- ined. After years of experience the Survey has adopted the Price rrent meter for general work. This meter, as is shown on Pl. II, made in two sizes, known as the large and small Price. The small rice has been largely developed by the officers of the Survey, using e Price acoustic meter as a basis.

A discharge measurement is the determination of the quantity of ater flowing past a certain point at a given time. This quantity is e product of two factors: (1) The mean velocity, which is the func- on of the cross section, surface slope, wetted perimeter, and rough- ess of bed; (2) the area, which depends upon the permanency of the ed and the fluctuations of the surface, which govern the depth.

; some appliance, generally a secondary cable, is necessary to the meter below the surface.

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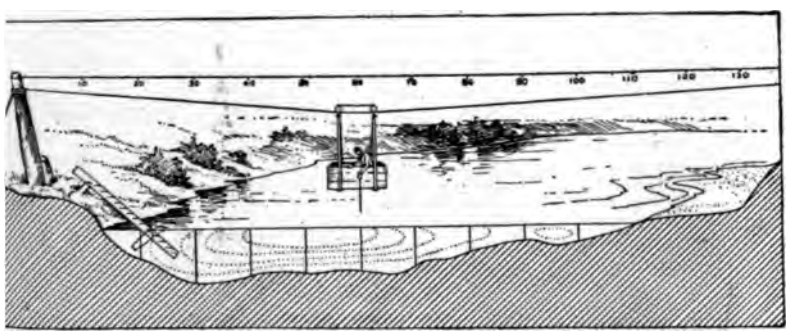

FIG. 1.—Cable station, showing section of river, car, gage, etc.

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In making the measurement an arbitrary number of points are laid off perpendicular to the thread of the stream (see fig. 1). These points are usually at regular intervals varying from 2 to 20 feet, depending upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity, or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenth depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between .94 and 1.04, with a mean for the 910 observations of 1.00. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from .85 to .95, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements, or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth

PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

into the area bounded by this mean velocity curve and the initial line. Owing to the length of time it takes to make these measurements they are seldom used except for determining coefficients for purposes of comparison and for measurements under ice.

In the second multiple-point method the meter is held from 0.5 to 1 foot below the surface and about 0.5 foot above the bottom, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is not well adapted for general work, as the roughness of the bottom disturbs the velocity at that point. For shallow streams with comparatively smooth beds good results are obtained by this method. In the third multiple point method the meter is held at mid depth, 0.5 foot below the surface, and 0.5 foot above the bottom, and the mean velocity is determined by dividing the sum of the top velocity, twice the mid-depth velocity, and the bottom velocity by 4.

The vertical-integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface. The number of revolutions and the time taken in the operation is noted, and the mean velocity is found by dividing the number of revolutions by the number of seconds taken in the run. This method has the advantage in that the velocity at each point of the vertical is measured twice. It is well adapted for measurements under ice and as a check on the point methods.

The area, which is the other factor for determining the discharge of the stream, depends upon the stage of the river, which is taken on a gage, and the general contour of the bed of the stream, which is found by sounding. The soundings are usually taken at each measuring point at the time of the discharge measurement, either by using the meter and cable or by a special sounding line or rod. For stations with permanent beds standard cross sections are usually taken during low water. These sections serve to check the soundings which are taken at the time of the measurements, and from them any change which may have taken place in the bed of the stream can be detected. They are also used for obtaining the area for use in high-water measurement computations, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at the various points of measurements the measuring section is divided into elementary strips, as shown in fig. 1, and the mean velocity, area, and discharge are determined separately for either a single or double strip. The total discharge and area are the sums of those for the various strips, and the mean velocity is obtained by dividing the total discharge by the total area.

The volume of water flowing in a stream is known as run-off. In expressing it various units are used, depending upon the kind of work for which the data are needed. Those used in this report are "second-

feet," "acre-feet," "run-off per square mile," and "run-off in depth in inches," and may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The "acre-foot" is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area on the assumption that the run-off is uniformly distributed.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow per second.

The base data for computing the daily discharge of a stream are the daily gage heights, and the various discharge measurements of which there should be sufficient number to cover the range of stage. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights. (2 and 3 depend on 1).

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent, or practically permanent, beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissas. Through these points a smooth curve is drawn, which shows the dis-

charge for any gage height, and from which a rating table is prepared. Aside from plotting the discharge, the mean velocity and area determined for each discharge measurement are plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mean velocity and the area at various stages as determined by these curves. These curves of mean velocity and area are of special value to determine the location of the rating curve for stages at which actual discharge measurements are not available and for extending the discharge curve outside the limits of the measurements. In the preparation of the rating table the discharge for each tenth or half tenth on the gage is found from the curve. The first and second differences of these discharges are then taken and adjusted according to the law that they shall either be constant or increasing, never decreasing. The discharges in the table are then changed in accordance with these adjusted differences. In making up the station-rating curve the individual discharge measurements and the conditions under which they were taken are carefully studied, in order that proper weight shall be given to each measurement. Rating curves in general take the form of a parabola, and as a rule the high-water portion of the curve approaches a straight line. For stations of permanent character the results of the measurements from year to year should be within 5 per cent of the curve, with the exception of those taken during high water, when the probable error may be as high as 10 per cent.

The determination of the daily discharge of streams with changeable beds is difficult, and unless frequent discharge measurements are made the results obtained are only roughly approximate. For streams with continually shifting beds, such as Colorado River and the Rio Grande, discharge measurements are made every two or three days, and the discharges for the intervening days are obtained by interpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed during floods, station-rating curves and tables can be prepared for the periods between changes, and satisfactory results can be obtained with two or three measurements a month, providing measurements are taken soon after the changes take place.

In determining the flow for periods when the streams are frozen, special rating curves and tables have to be prepared from measurements taken under these conditions. The methods of constructing these curves and tables are the same as for open sections. The discharge measurements, however, are either taken by integration in verticals or by the vertical velocity-curve method, as sufficient experiments have not been made on ice-covered streams to determine the laws which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar Year 1904, of which this is Part V, is published in a series of twelve Water-Supply Papers, Nos. 124–135, inclusive, under the following subtitles:

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha rivers, and Eastern Gulf of Mexico drainage.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meremac, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainage in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations and such other information that has been collected that has a direct bearing on these data including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage heights gives for each day the mean height of the surface of the river as found from the mean of the gage read-

's taken on that day. At most of the stations the gage is read in morning and in the evening.

The rating table gives discharges in second-feet corresponding to h stage of the river as given by the gage heights.

In the table of estimated run-off the column headed "Maximum" es the mean flow for the day when the mean gage height was the hest, and it is the flow as given in the rating table for that mean gage ght. As the gage height is the mean for the day, there might have n short periods when the water was higher and the corresponding charge larger than given in this column. Likewise in the column "Minimum" the quantity given is the mean flow for the day when mean gage height was lowest. The column headed "Mean" gives average flow for each second during the month. Upon this mean computations for the three remaining columns which are defined page 12 are based.

In the computations for the tables of this report the following gen- al and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and ney is imperative.

2. All items of computation should in general be expressed by at least two and by t more than four significant figures.

3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose r cent of error is 5 times the average per cent error of all the other measurements ould be rejected.

4. In reducing the number of significant figures, or the number of decimal places, dropping the last figure, the following rules apply:

(a) When the figure in the place to be rejected is less than 5, drop it without anging the preceding figure. Example: 1,827.4 becomes 1,827.

(b) When the figure in the place to be rejected is greater than 5, drop it and rease the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(c) When the figure in the place to be rejected is 5, and it is preceded by an even ure, drop the 5. Example: 1,828.5 becomes 1,828.

(d) When the figure in the place to be rejected is 5, and it is preceded by an odd ure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 828.

5. In constructing and applying rating tables a maximum limit of one-half per cent ror should seldom be exceeded.

Special rules for computation.

1. Rating tables are to be constructed as close as the data upon which they are sed will warrant. No decimals are to be used when the discharge is over 50 econd-feet.

2. Daily discharges shall be applied directly to the gage heights as they are abulated.

3. Monthly means are to be carried out to one decimal place when the quantities re below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the nonthly mean shall be a significant figure. This also applies to the yearly mean.

4. Second-feet per square mile and depth in inches for the individual months shall be carried out at least to three significant figures, except in the case of decimals, where the first significant figure is preceded by one or more naughts (0), when the quantity shall be carried out to two significant figures. Example: 1.25; .125; .012; .0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of these reports is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive.
West of Mississippi River, Water Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at little above cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained rough local hydrographers. Acknowledgment is extended to other rsons and corporations who have assisted local hydrographers or ve cooperated in any way, either by furnishing records of the height water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the mes of the resident hydrographers and others who have assisted in rnishing and preparing the data contained in this report:

Alabama.—District hydrographer, M. R. Hall,[a] assisted by J. M. Giles, W. E. Hall, d B. S. Drane.

Illinois.—District hydrographer, E. Johnson, jr.,[b] assisted by E. H. Heilbron, istant engineer, sanitary district of Chicago. Acknowledgment is due to the Ster-g Manufacturing Company for the establishment of two chain gages on the Avenue bridge, Sterling, Ill.

Indiana.—District hydrographer, E. Johnson, jr., assisted by F. W. Hanna, assist-t engineer. Acknowledgment should also be made to Joseph M. Steiner and O. H. iest, who have assisted the Survey in establishing stations and supplying voluntary ıdings at Cataract and Shoals, Ind.

Maryland.—Resident hydrographer, E. G. Paul, during the first half and N. C. over[c] during the last half of the year, assisted by H. D. Comstock. Acknowledg-ent is due to the State Geological Survey for cooperation in the work to the extent paying the observers.

Minnesota.—District hydrographer, E. Johnson, jr., assisted by E. F. Chandler, istant engineer, University, N. Dak.

Mississippi.—District hydrographer, M. R. Hall, assisted by J. M. Giles, B. S. Drane, d W. E. Hall.

New York.—District hydrographer, R. E. Horton,[d] assisted by C. C. Covert. ecial acknowledgment is made of the interest and assistance of Hon. Edward A. nd, State engineer, and William Pierson Judson, deputy State engineer.

North Carolina.—District hydrographer, M. R. Hall, assisted by J. M. Giles, B. S. ane, and O. P. Hall. Dr. C. A. Schenck, director of the Biltmore School of restry, paid the gage readers at Davidsons River, Sitton, and Pinkbed.

Ohio.—District hydrographer, E. Johnson, jr., assisted by R. W. Pratt, engineer the State board of health. Acknowledgment should also be made to the Baltimore d Ohio Railroad for passes issued to E. Johnson, jr., and R. W. Pratt.

Pennsylvania.—Resident hydrographer, E. G. Paul during the first half and N. C. over during the last half of the year, assisted by R. J. Taylor and H. D. Comstock.

Tennessee.—District hydrographer, M. R. Hall, assisted by J. M. Giles, B. S. Drane, d O. P. Hall. Gage heights for stations at Nashville, Chattanooga, Knoxville, gersville, and part of the year at Bluff City, were furnished by United States eather Bureau officials H. C. Bate, L. M. Pindell, and Levi A. Judkins.

West Virginia.—Resident hydrographer, E. G. Paul in the first half and N. C. over in the last half of the year.

Wisconsin.—District hydrographer, E. Johnson, jr.

The office of the district hydrographer for South Atlantic States and Eastern Gulf of Mexico, 409 mple Court, Atlanta, Ga.

The office of the district hydrographer for Mississippi Valley, 876-7 Federal Building, Chicago, Ill.

The office of the resident hydrographer for North Atlantic States, United States Geological Sur-y, Washington, D. C.

The office of the district hydrographer for New York and Michigan, 75 Arcade, Utica, N. Y.

MISSISSIPPI RIVER DRAINAGE BASIN.

MISSISSIPPI RIVER NEAR SAUK RAPIDS, MINN.

This station was established by W. R. Hoag April 23, 1903. It is located about 1½ miles south of Watab station, on the Northern Pacific Railroad, and about 5 miles north of Sauk Rapids, 7 miles north of St. Cloud. The gage is a vertical timber fastened to a post driven into the bed on the left side of the river. It is read daily by Frank McCrea. Discharge measurements are made from a boat running on a $\frac{5}{16}$-inch cable, which is securely fastened to trees on each side of the river. The point to which the soundings are referred is a nail head in the root of a tree on the left bank, to which the cable is fastened. The channel is straight for 4,000 feet above the station and for 600 feet below. Both banks are high and not subject to overflow. The bed consists of sand and gravel, and is somewhat shifting. There is but one channel at all stages. The channel has a width of about 625 feet at low water and about 700 feet at high stages.

Bench mark No. 1 is the top of a large pointed rock 150 feet upstream from the gage and 10 feet from the water's edge. Its elevation above the zero of the gage is 18.58 feet. Bench mark No. 2 is a ⅝-inch iron stake, driven on the left shore between the cable and bench mark No. 1. Its elevation is 14.22 feet above the zero of the gage. Bench mark No. 3 is on the root of a small tree on the left bank just below the cable. Its elevation is 18.29 feet above the zero of the gage. A short distance above the old gage is a large rock with a vertical face at an elevation of 14.45 feet above the zero of the gage. Observations of the river height can be made by determining distances from the top of this rock to the water surface.

The drainage area at this station is 12,340 square miles.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

charge measurements of Mississippi River near Sauk Rapids, Minn., in 1904.

ate.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
y 5[a]	E. Johnson, jr.	515	2,201	0.94	10.20	2,473
0	E. F. Chandler	585	4,171	2.94	14.26	12,250
	do	577	3,790	2.12	13.31	8,019
	R. Richards	557	2,678	1.77	11.38	4,745
22[b]	do	572	3,404	1.28	12.76	4,344
ber 8[b]	do	561	2,858	1.68	11.77	4,802
r 15	E. F. Chandler	578	3,815	2.45	13.75	9,348

[a] Frozen over. [b] Log jam below station.

aily gage height, in feet, of Mississippi River near Sauk Rapids, Minn., for 1904.

	Jan.[a]	Feb.[a]	Mar.[a]	Apr.[b]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[c]
...	11.60	11.20	11.32	14.00	14.50	13.35	13.30	11.00	12.85	12.20	13.00	11.70
...	11.70	11.20	11.36	14.10	14.30	13.40	13.25	11.05	12.90	12.20	12.90	11.85
...	11.80	11.28	11.44	14.60	14.40	13.60	12.90	11.35	12.90	12.00	12.80	11.85
...	11.80	11.28	11.52	15.50	14.30	14.00	12.75	11.20	11.30	12.00	12.70	11.75
...	[d] 11.60	11.28	11.52	15.90	14.25	14.50	12.60	11.05	11.35	12.20	12.60	11.70
...	11.60	11.28	11.58	17.00	14.25	14.65	12.60	11.00	11.40	12.20	12.40	11.75
...	11.60	11.28	11.57	17.00	14.25	14.75	12.85	10.95	11.80	12.10	12.20	11.85
...	11.50	11.28	11.61	19.60	14.30	14.60	12.85	11.00	11.75	12.15	12.20	11.95
...	11.50	11.28	11.61	17.10	14.40	14.45	12.80	11.05	11.70	12.50	12.35	11.60
...	11.48	11.28	11.61	17.00	14.50	14.35	12.65	11.60	11.55	13.60	12.30	11.60
...	11.48	11.32	11.70	15.90	14.60	14.25	12.45	11.70	11.45	13.75	12.30	11.60
...	11.61	11.32	11.70	15.00	14.60	14.10	12.30	11.75	11.40	13.85	12.25	11.40
...	11.61	11.32	11.70	14.70	14.50	13.95	12.50	11.75	11.30	13.90	12.20	11.35
...	11.52	11.32	11.70	14.50	14.45	13.80	12.45	11.65	11.40	13.90	12.15	11.25
...	11.61	11.28	11.70	14.40	14.45	13.65	12.50	11.50	11.50	13.75	11.90	11.15
...	11.70	11.28	11.70	14.40	14.30	13.45	12.60	11.40	11.40	13.75	12.15	11.10
...	11.70	11.24	11.70	14.35	14.30	13.20	12.35	11.80	11.30	13.75	12.05	11.05
...	11.61	11.20	11.70	14.35	14.20	13.10	12.50	11.85	11.30	13.75	12.00	11.00
...	11.61	11.20	11.70	14.35	14.00	12.90	12.65	11.75	11.25	13.95	11.90	10.85
...	11.52	11.28	11.70	14.25	13.80	12.60	12.75	12.60	11.20	14.00	11.80	10.90
...	11.52	11.28	11.78	14.15	13.75	12.55	12.70	12.65	11.40	13.95	11.70	10.90
...	11.44	11.28	11.78	14.05	13.70	12.40	12.50	12.80	11.50	13.90	11.70	10.90
...	11.36	11.28	11.78	14.30	13.50	12.30	11.80	12.45	11.60	13.95	11.70	10.90
...	11.36	11.28	11.78	14.55	13.60	12.15	11.40	12.45	11.65	14.05	11.70	10.90
...	11.36	11.28	11.78	14.60	13.65	12.45	11.30	12.60	11.80	13.90	11.65	10.80
...	11.36	11.28	11.78	14.70	13.50	12.75	11.30	12.80	11.75	13.80	11.65	10.90
...	11.28	11.28	11.90	14.90	13.40	12.80	11.50	12.75	11.75	13.60	11.50	11.00
...	11.28	11.28	11.90	14.80	13.35	12.35	11.30	12.50	12.10	13.50	11.35	11.10
...	11.20	11.28	12.00	14.80	13.25	12.85	11.25	12.40	12.20	13.40	11.10	11.15
...	11.20	.....	12.20	14.70	13.15	13.20	11.20	12.45	12.20	13.30	11.00	11.20
...	11.20	.....	12.70	.....	13.25	.....	11.15	12.80	.....	13.20	.....	11.30

tiver frozen from January 1 to March 31, 1904. Average thickness of ice about 9 inches.
ce conditions April 1 to about April 8. April 6 and 7 ice gorge.
'rozen December 1 to 31.
)n January 5 from surface of water to under side of ice was 1.3 feet.

CHIPPEWA RIVER DRAINAGE BASIN.

Chippewa River rises in the southeastern part of Ashland County, Wis. It flows southwest, emptying into the Mississippi near Wabasha, Minn. Its principal tributary is the Flambeau, which enters from the east in Gates County. During the latter part of 1902 the United States Geological Survey began systematic measurements in this and other drainage basins of Wisconsin.

Gaging stations have been maintained in this basin on the Chippewa at Eau Claire, and on the Flambeau at Ladysmith, Wis.

CHIPPEWA RIVER NEAR EAU CLAIRE, WIS.

This station was established November 13, 1902, by L. R. Stockman. It is located 2 miles below Eau Claire, at a suburb known as Shawtown. Discharge measurements are made from a two-span highway bridge. A standard chain gage is fastened to the downstream side of highway bridge, having a length of 30.69 feet from the end of the weight to the marker. The gage is read twice each day by Joseph E. Kimpton. The channel is straight above and below the station, and the current is swift. The right bank is protected by a high masonry wall. The left bank is low, but the water is confined by an earthen embankment. The bed is composed of gravel, with a few rocks, and is permanent. There are two channels at all stages. The width is 450 feet at low water and 500 feet at flood stages.

Bench mark No. 1 is a nail in the top of a 6-inch white-oak stump which is attached to a tree still standing. It is located about 200 feet east of the road and 200 feet south of the river. Its elevation is 20.09 feet above the zero of the gage. The initial point for soundings is a point marked by two nails in the footway at the right end of the bridge, also marked 0 in white paint.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Chippewa River near Eau Claire, Wis., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Second-ft.*
y 11 [a] ...	E. Johnson, jr	310	2,429	0.99	3.80	2,454
.....	.....do	385	4,272	3.42	8.40	14,610
.....	Johnson and Hanna	370	4,074	3.10	7.60	12,630
.....	E. Johnson, jr	426	5,815	4.52	11.25	26,270
.....	.....do	354	3,770	2.10	6.55	7,918
28.....	.....do	322	2,766	.82	4.20	2,274
ber 19 ..	.....do	329	3,122	1.47	5.25	4,581
r 12.....	F. W. Hanna	495	7,118	5.43	14.80	38,680
r 13.....	.....do	457	6,137	4.76	13.10	29,200
ber 29 ..	E. Johnson, jr	324	2,847	.80	4.44	2,281

[a] Frozen.

n daily gage height, in feet, of Chippewa River near Eau Claire, Wis., for 1904.

	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
.....	[c] 4.90	.....	.....	6.25	9.00	8.45	8.10	4.42	4.58	6.31	6.79	3.93
.....	[c] 5.15	.....	.....	6.72	8.65	7.65	8.52	4.80	5.05	5.24	6.84	3.92
.....	.....	.....	.....	6.50	8.63	7.65	8.28	4.38	8.18	8.27	6.80	3.93
.....	[c] 5.00	.....	.....	6.52	8.28	8.85	8.02	4.78	7.52	5.65	6.61	3.45
.....	.....	.....	[d] 4.80	6.60	8.10	9.00	10.32	4.32	8.30	5.30	5.91	4.42
.....	.....	[e] 4.80	.....	7.17	8.03	10.96	10.12	4.12	7.30	5.27	6.41	4.28
.....	.....	.....	.....	7.60	10.13	11.30	9.63	3.45	7.52	4.82	6.08	4.26
.....	.....	.....	.....	9.10	8.50	10.85	8.93	4.62	7.12	9.12	5.35	4.28
.....	[c] 4.80	.....	.....	9.67	8.83	9.85	7.22	5.10	6.72	7.86	5.35	4.37
.....	.....	.....	.....	9.72	9.35	8.92	7.10	5.42	7.95	13.35	5.60	4.36
.....	.....	.....	.....	9.70	9.25	7.95	7.20	5.35	5.03	15.07	5.36	4.20
.....	.....	.....	[e] 4.95	9.32	8.85	7.80	6.72	4.38	5.28	14.93	5.02	4.34
.....	.....	[d] 5.00	.....	9.05	8.78	7.80	6.60	4.12	5.42	13.15	6.27	4.39
.....	.....	.....	.....	8.82	10.20	7.45	5.88	3.50	5.35	11.38	4.82	4.20
.....	.....	.....	.....	8.50	8.00	7.80	5.07	3.80	5.38	10.30	6.26	4.34
.....	[c] 5.00	.....	.....	7.55	8.20	8.35	5.55	4.55	5.42	9.17	5.42	4.32
.....	.....	.....	.....	7.25	7.55	6.25	5.35	4.82	7.10	8.10	5.30	4.15
.....	.....	.....	.....	7.50	7.22	5.50	5.60	4.65	4.80	8.00	5.47	4.19
.....	.....	[d] 5.10	4.45	8.38	7.55	5.10	5.50	4.78	4.89	7.08	5.20	4.53
.....	.....	.....	4.07	8.20	6.93	6.20	5.10	7.20	4.27	6.85	4.98	4.29
.....	.....	.....	4.45	8.13	10.30	6.50	5.47	5.25	4.30	8.35	5.28	4.34
.....	.....	.....	4.37	7.45	6.30	5.90	5.05	4.75	4.35	9.25	5.23	4.37
.....	[c] 5.00	.....	4.32	8.05	6.83	5.80	4.75	4.68	5.10	9.42	5.74	4.55
.....	.....	.....	5.62	8.50	7.33	5.50	3.93	4.60	4.24	9.00	4.77	4.38
.....	.....	.....	5.95	9.65	9.20	8.95	4.07	5.00	5.76	8.78	4.94	3.31
.....	.....	.....	6.45	10.63	12.00	5.55	4.90	5.40	8.18	7.81	5.10	4.19
.....	.....	[d] 5.30	6.10	10.45	13.48	7.75	4.80	8.15	7.61	8.02	4.85	4.55
.....	.....	.....	5.72	9.18	13.63	7.60	5.00	3.58	6.93	7.22	4.55	.....
.....	[e] 4.70	.....	5.05	9.55	12.02	7.75	4.88	5.55	9.81	7.55	4.54	.....
.....	.....	.....	5.10	9.03	10.67	7.50	6.45	4.92	6.65	7.30	4.46	.....
.....	.....	.....	5.32	.....	9.20	.....	5.00	4.52	.....	6.85	.....	.....

[a] frozen over January 1 to March 18, 1904, but open about 200 to 300 feet above and one-fourth ow bridge.
[b] n December 28 to 31.
[c] 0 feet thick at gage; 1.0 foot in middle of channel.
[d] 5 feet thick at gage; 2.5 feet in middle of channel.
[e] 0 feet thick at gage; 2.0 feet in middle of channel.

Rating table for Chippewa River near Eau Claire, Wis., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.7	1,240	4.8	3,590	5.9	6,610	8.0	13,290
3.8	1,410	4.9	3,850	6.0	6,900	8.5	14,980
3.9	1,590	5.0	4,120	6.2	7,490	9.0	16,680
4.0	1,780	5.1	4,390	6.4	8,100	9.5	18,380
4.1	1,980	5.2	4,660	6.6	8,720	10.0	20,080
4.2	2,180	5.3	4,930	6.8	9,350	10.5	21,780
4.3	2,390	5.4	5,200	7.0	9,990	11.0	23,480
4.4	2,610	5.5	5,480	7.2	10,650	11.5	25,210
4.5	2,840	5.6	5,760	7.4	11,310	12.0	26,960
4.6	3,080	5.7	6,040	7.6	11,970	13.0	30,500
4.7	3,330	5.8	6,320	7.8	12,630	14.0	34,480

The above table is applicable only for open-channel conditions. It is based upon 23 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 4.20 feet and 14.80 feet.

Estimated monthly discharge of Chippewa River near Eau Claire, Wis., for 1904.

[Drainage area, 6,740 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 19–31	8,255	1,920	4,622	0.686	0.332
April	22,220	7,640	14,550	2.16	2.41
May	32,900	7,790	16,960	2.52	2.90
June	24,510	4,390	12,600	1.87	2.09
July	21,170	1,647	8,525	1.26	1.45
August	13,790	650	3,778	.561	.647
September	19,430	2,264	7,801	1.16	1.29
October	40,400	3,642	15,170	2.25	2.59
November	9,478	2,748	5,576	.827	.923
December 1–27	2,960	380	2,230	.331	.332

FLAMBEAU RIVER NEAR LADYSMITH, WIS.

This station was established February 13, 1903, by L. R. Stockman. It is located three-fourths mile south of the Minneapolis, St. Paul and Sault Ste. Marie Railroad station, three-fourths mile south of Lady-

one-half mile below the dam of the Menasha Pulp Com-
charge measurements are made from a three-span highway
standard chain gage is fastened to the upstream side of the
The length of the chain from the end of the weight to
is 25.40 feet. The gage is read twice each day by Leon-
dless. The initial point for soundings is a point marked
ls and a straight white line at the right end of the bridge.
el is straight for about 500 feet above and below the sta-
right bank is low, but the overflow passes beneath the
he left bank is high and covered with trees. The gaging
road and shallow, with a bed of small bowlders, gravel,
nd is not liable to shift. The stream is divided into three
the bridge piers. The channels are somewhat obstructed
s during the rafting season. The bench mark is a cut on a
on the post to which the pulley of the chain gage is attached.
gage reads zero this mark is 36.28 feet above the water
An arrow cut on the iron guard rail is exactly opposite the
rk of the scale of the chain gage.
rvations at this station during 1904 have been made under
on of E. Johnson, jr., district hydrographer.

easurements of Flambeau River near Ladysmith, Wis., for 1903 and 1904.

	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
..	L. R. Stockman	325	472	1.64	16.20	773
...	do	366	1,871	1.77	18.95	3,312
...	do	349	1,330	2.80	17.40	3,727
...	do	361	1,927	3.70	18.97	7,113
...	do	342	703	1.91	16.00	1,345
...	do	342	1,430	2.95	18.10	4,222
...	do	342	995	2.69	16.85	2,681
) ..	E. C. Murphy	364	1,579	3.36	18.05	5,303
...	L. R. Stockman	348	1,271	3.07	17.21	3,899
...	E. Johnson, jr	350	1,333	3.15	17.88	4,203
...	do	350	1,448	2.99	17.45	4,321
...	do	349	733	2.07	16.06	1,517
) ..	do	343	702	2.21	16.01	1,554
...	F. W. Hanna	364	1,653	3.37	18.58	5,588

[a] Frozen. [b] Log jam below.

Mean daily gage height, in feet, of Flambeau River near Ladysmith, Wis., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.[b]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[c]
1	16.75	16.75	17.00	16.90	18.70	17.50	17.58	15.15	16.25	([d])	17.25	15.65
2	16.95	16.75	17.05	17.20	18.55	17.40	17.77	15.40	16.30	([d])	17.30	15.05
3	16.75	16.10	17.00	16.80	18.60	17.42	17.70	([e])	16.38	([d])	17.20	15.95
4	16.85	16.80	17.05	16.90	18.35	17.43	19.90	([e])	17.78	([d])	16.90	14.50
5	17.00	16.90	17.15	16.85	18.45	18.00	18.82	15.60	17.65	16.05	16.70	15.15
6	16.50	16.70	16.95	16.80	18.60	18.02	18.88	15.72	17.20	16.05	16.80	15.30
7	16.50	16.80	16.90	17.10	18.60	18.25	18.75	15.13	17.28	16.10	16.30	14.87
8	16.65	16.75	17.15	17.25	18.85	18.27	18.75	15.40	17.30	16.10	16.20	15.78
9	16.65	16.75	16.90	17.05	19.20	17.90	18.05	15.75	17.03	17.05	16.17	15.57
10	16.70	16.65	17.50	17.00	19.15	17.22	17.95	15.92	16.00	18.70	16.15	15.55
11	16.60	16.70	17.40	17.10	18.90	17.10	17.70	15.85	16.40	18.65	16.05	15.25
12	16.55	16.95	17.05	17.10	18.80	17.25	17.25	16.00	16.32	18.60	15.55	15.77
13	16.50	17.00	17.30	17.15	18.35	17.15	16.40	15.90	16.45	18.50	15.60	15.55
14	16.70	16.70	17.20	17.05	18.15	17.12	16.30	15.90	16.30	18.43	15.45	15.30
15	16.70	16.90	17.20	17.25	18.01	16.60	16.12	15.85	16.15	18.30	15.82	15.35
16	16.75	16.95	17.00	17.20	17.95	16.55	16.15	16.02	16.05	17.85	15.28	15.45
17	16.60	16.55	17.15	17.10	18.01	16.35	16.03	15.90	16.05	17.20	15.55	15.35
18	16.60	17.10	17.20	17.05	18.01	16.25	16.00	15.85	16.13	16.95	15.72	15.30
19	16.65	16.95	17.15	17.00	18.03	16.32	15.60	15.95	16.15	17.15	15.70	15.50
20	16.30	16.95	17.05	16.85	17.05	15.95	15.80	15.75	16.00	17.25	15.60	15.57
21	16.75	17.55	17.05	16.85	17.03	15.88	15.95	16.00	16.00	17.60	15.45	15.70
22	16.75	16.90	17.15	16.65	17.01	16.15	15.85	16.20	15.90	17.80	15.82	15.72
23	16.75	17.00	16.85	17.20	17.04	15.95	15.80	15.35	15.95	17.75	15.27	15.60
24	16.65	16.60	17.15	17.20	17.06	16.35	15.70	16.45	15.95	17.75	15.55	15.60
25	16.70	17.00	16.95	18.00	18.40	16.55	15.85	16.65	16.40	17.85	15.72	15.65
26	16.70	16.90	16.95	18.40	19.00	16.70	16.15	16.45	16.40	17.75	15.70	15.70
27	16.45	17.00	16.95	18.45	19.40	16.95	16.76	16.45	16.40	17.65	15.55	16.10
28	16.65	16.95	17.15	18.50	19.30	17.05	16.75	16.20	16.45	17.55	15.40	15.75
29	16.60	16.95	17.05	18.50	18.80	17.05	15.70	16.10	16.40	17.65	14.95	15.80
30	16.75	.....	16.45	18.90	18.40	17.20	15.25	16.27	16.45	17.70	15.55	16.30
31	16.65	.....	17.20	.....	17.80	.....	15.55	16.15	.....	17.22	.....	16.40

[a] Frozen from January 1 to March 30, when ice begins to break. Ice varied rom 6 to 18 inches in thickness.
[b] Ice conditions March 31 to about April 10.
[c] Ice conditions during December.
[d] Weight gone.
[e] Key lost. No gage height taken on August 3 and 4.

Rating table for Flambeau River near Ladysmith, Wis., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
15.0	567	16.0	1,399	17.0	2,841	18.4	5,291
15.1	596	16.1	1,542	17.1	2,990	18.6	5,704
15.2	637	16.2	1,686	17.2	3,143	18.8	6,120
15.3	690	16.3	1,830	17.3	3,300	19.0	6,539
15.4	755	16.4	1,974	17.4	3,461	19.2	6,959
15.5	832	16.5	2,118	17.5	3,626	19.4	7,379
15.6	921	16.6	2,262	17.6	3,795	19.6	7,799
15.7	1,022	16.7	2,406	17.8	4,145	19.8	8,219
15.8	1,135	16.8	2,550	18.0	4,511	20.0	8,639
15.9	1,260	16.9	2,695	18.2	4,893		

The foregoing table is applicable only for open-channel conditions. It is based pon fourteen discharge measurements made during 1903 and 1904. It is well defined etween gage heights 16 feet and 19 feet. The table has been extended beyond these mits. Above gage height 18.9 feet the rating curve is a tangent, the difference being 10 per tenth.

Estimated monthly discharge of Flambeau River near Ladysmith, Wis., for 1904.

[Drainage area, 2,120 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
pril [a]	6,339	2,334	3,389	1.60	1.78
lay	7,379	2,856	5,183	2.44	2.81
une	5,034	1,234	2,890	1.36	1.52
uly	8,429	662	2,834	1.34	1.54
ugust [b]	2,334	607	1,336	.630	.726
eptember	4,109	1,260	2,056	.970	1.08
ctober [b]	5,912	1,470	3,517	1.66	1.91
ovember	3,300	555	1,416	.668	.745
ecember [a]	1,974	390	951	.449	.518

[a] Estimates April and December made as if open channel.
[b] Discharge estimated for August 3 and 4 and October 1 to 4.

WISCONSIN RIVER DRAINAGE BASIN.

Wisconsin River is the largest river in the State of Wisconsin. It ises in the northern part and flows south through the central por- ion of the State to Portage, where it turns at nearly a right angle nd flows west, emptying into the Mississippi about 60 miles above)ubuque.

Gaging stations were operated at Necedah and Merrill, Wis., during 904.

WISCONSIN RIVER AT MERRILL, WIS.

This station was established November 17, 1902, by L. R. Stock- nan. It is located on the highway bridge in the city of Merrill, Wis., hree blocks from the Lincoln County court-house, one-half mile rom the Chicago, Milwaukee and St. Paul Railroad station, and 1,000 eet below the dam of the electric power house. Prairie River enters bout one-half mile above the station and there is an island about 600 eet below. There is a vertical gage fastened to the mill abutment, rom which part of the gage readings for 1903 have been made. une 17, 1903, a chain gage was established on the bridge and made o read the same as the old gage at the mill. It is fastened to the uard timber on the downstream side, and the zero is marked by a rass screw driven into the guard timber. The fall of the water rom the old to the new gage is 2.70 feet when the water is at a high

stage. The length of the chain from the end of the weight tc marker is 23.68 feet. The gage is read twice each day by A Lueck. The initial point for soundings is a nail in the footboa the left end of the bridge, opposite the center of the iron hanc post. This point is marked "zero." Discharge measurements made from the two-span highway bridge, to which the chain ga fastened. Each span of the bridge is 175 feet in length. The c nel is straight from the dam above to the bridge and for about feet below. The velocity is rapid and the surface rough. station is so near the dam that at high stages the velocity is affe and it is possible that the bed of the stream may be subject to s change, although it is of rock and gravel and is very rough. channel is about 300 feet wide at low stages and 400 feet wide at water. Both banks are high and do not overflow. Bench mark 1 is a cross cut in the sandstone rock in the bridge seat of the s ment nearest to the city. Its elevation above the zero of the ga 16.25 feet. This bench mark is 18.28 feet below the United S bench mark located at the corner of the engine house opposite city hall.

The observations at this station during 1904 have been made u the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Wisconsin River at Merrill, Wis., in 1903 and 1904

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	ch
1903.		*Feet.*	*Sq. feet.*	*Feet per sec.*	*Feet.*	*S*
January 20 [a]	L. R. Stockman	310	718	1.91	4.05	
February 16 [a]	do	310	669	1.86	3.70	
March 20	do	344	2,639	3.78	8.90	
May 7 [b]	do	332	2,232	3.54	6.85	
June 17 [b]	do	308	1,269	1.78	4.72	
July 13	do	305	1,424	2.10	5.70	
August 22 [b]	do	283	1,115	2.36	5.00	
September 11	E. C. Murphy	343	1,759	3.19	6.66	
October 24	L. R. Stockman	334	1,594	2.61	6.08	
1904.						
May 12 [b]	E. Johnson, jr	334	2,220	3.71	7.85	
June 5	do	334	2,286	4.19	8.25	
July 15 [b]	do	334	1,366	1.98	5.30	
September 21	do	312	1,210	1.91	5.01	
October 14	F. W. Hanna	327	2,333	4.42	8.25	1
November 30 [a]	E. Johnson, jr	306	1,237	1.85	4.97	

[a] Partly frozen. [b] Effected by log jam.

Mean daily gage height, in feet, of Wisconsin River at Merrill, Wis., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	5.90	5.65	5.90	5.90	7.55	7.55	6.75	5.15	5.05	6.15	6.70	4.85
.....	6.00	5.65	5.95	5.85	7.10	7.25	6.80	5.20	4.90	6.25	6.60	5.20
.....	6.05	5.60	5.90	5.90	6.80	7.30	6.60	5.10	5.95	6.70	6.25	4.85
.....	6.10	5.55	5.90	5.85	7.05	7.70	6.20	5.00	7.80	5.85	5.90	4.85
.....	6.10	5.70	5.90	5.90	7.30	8.05	6.25	5.05	6.90	6.40	5.75	4.75
.....	6.00	5.70	5.85	6.40	6.75	8.30	6.20	5.25	6.25	5.90	5.70	4.95
.....	5.75	5.60	5.95	6.35	6.75	7.80	6.20	5.20	7.05	5.60	5.55	4.80
.....	5.80	5.80	5.85	6.65	7.05	7.85	6.35	6.65	7.00	6.70	5.15	5.15
.....	5.50	5.80	5.90	7.20	8.40	7.55	6.70	5.10	6.75	7.75	4.70	5.00
.....	5.85	5.75	5.90	7.15	8.20	7.35	6.95	5.20	5.90	10.10	4.55	5.00
.....	5.55	5.85	5.90	7.15	7.90	7.00	7.20	5.30	6.15	10.40	4.40	4.65
.....	5.70	5.75	5.90	6.75	7.95	7.55	6.55	6.20	6.60	10.15	4.75	4.45
.....	5.75	6.10	5.80	6.80	7.70	7.25	5.45	7.15	6.15	9.05	5.90	4.80
.....	5.70	5.55	5.80	6.65	7.95	6.50	6.00	5.50	5.95	8.30	6.00	5.05
.....	5.55	5.60	5.90	6.35	7.70	6.20	5.75	5.30	5.95	7.55	4.60	5.20
.....	5.60	5.65	5.85	5.85	7.90	6.10	5.60	5.70	5.90	7.15	4.50	5.30
.....	5.60	5.95	5.90	6.45	7.40	6.05	5.80	6.65	5.90	6.90	4.55	5.20
.....	5.55	5.90	5.75	6.30	6.55	6.10	6.05	5.90	5.95	6.90	4.55	5.20
.....	5.65	5.90	5.65	6.35	6.75	6.50	4.50	5.75	5.90	6.95	4.75	5.10
.....	5.60	6.15	5.70	6.15	6.75	6.20	4.60	6.40	5.20	6.25	5.05	5.05
.....	5.70	5.85	5.75	6.05	6.85	6.05	5.10	6.10	5.35	6.35	5.10	5.20
.....	5.65	5.95	5.80	6.05	7.05	6.10	5.20	6.20	5.05	6.80	5.25	5.70
.....	5.60	5.90	5.35	6.10	7.05	6.05	5.30	6.15	5.50	6.65	5.10	5.25
.....	5.50	5.90	5.75	7.00	7.05	7.25	4.90	5.85	6.80	6.55	4.95	5.20
.....	5.85	5.90	6.00	8.10	8.10	5.60	4.50	5.80	7.10	7.10	4.75	5.45
.....	5.55	5.90	5.85	8.35	10.10	6.00	4.60	5.70	7.75	7.20	4.95	5.05
.....	5.55	5.90	5.55	8.45	10.60	6.25	5.40	6.00	7.15	6.90	5.45	5.60
.....	5.55	5.90	5.70	8.50	9.80	7.25	5.10	5.50	7.20	6.75	5.15	5.95
.....	5.55	5.95	5.80	8.20	9.05	6.80	5.50	5.90	6.40	6.85	5.15	5.60
.....	5.55	.....	5.70	7.75	8.60	6.30	5.70	6.35	6.10	6.65	4.85	5.50
.....	5.50	.....	5.80	.....	7.95	.....	5.50	5.05	.....	6.25	.....	5.15

ating table for Wisconsin River at Merrill, Wis., from June 17, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.5	1,485	5.5	3,225	6.5	5,485	8.0	9,565
4.6	1,645	5.6	3,425	6.6	5,725	8.2	10,225
4.7	1,805	5.7	3,635	6.7	5,975	8.4	10,885
4.8	1,970	5.8	3,855	6.8	6,225	8.6	11,545
4.9	2,140	5.9	4,075	6.9	6,475	8.8	12,205
5.0	2,310	6.0	4,305	7.0	6,725	9.0	12,865
5.1	2,485	6.1	4,535	7.2	7,245	9.5	14,515
5.2	2,665	6.2	4,765	7.4	7,785	10.0	16,165
5.3	2,845	6.3	5,005	7.6	8,345	10.5	17,815
5.4	3,035	6.4	5,245	7.8	8,935	11.0	19,465

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1902 to 1904, inclusive. It is not well efined. Above gage height 8 feet the rating curve is a tangent, the difference being 30 per tenth.

Estimated monthly discharge of Wisconsin River at Merrill, Wis., for 1904.

[Drainage area, 2,630 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,535	3,225	3,664	1.39	1.60
February	4,655	3,330	3,749	1.43	1.54
March	4,305	2,945	3,889	1.48	1.71
April	11,220	3,970	6,242	2.37	2.64
May	18,140	5,610	8,935	3.40	3.92
June	10,560	3,425	6,472	2.46	2.74
July	7,245	1,485	3,957	1.51	1.74
August	7,110	2,310	3,766	1.43	1.65
September	8,935	2,140	5,000	1.90	2.12
October	17,480	3,425	7,343	2.79	3.22
November	5,975	1,410	2,800	1.06	1.18
December	4,195	1,490	2,566	.976	1.12
The year	18,140	1,410	4,865	1.85	25.18

WISCONSIN RIVER NEAR NECEDAH, WIS.

This station was established December 2, 1902, by L. R. Stockman. It is located on the highway toll bridge 3 miles east of Necedah, Wis., and 3 miles from the Chicago, Milwaukee and St. Paul and Chicago and Northwestern Railroad stations. Yellow River flows into the Wisconsin about 4 miles below the station. There are islands both above and below the station, but they are several hundred feet away. A regulation chain gage is fastened to the upstream side of the highway bridge. The length from the end of the weight to the marker is 26.87 feet. The gage is read daily by W. F. Bingman. Discharge measurements are made from the two-span highway bridge to which the gage is attached. The initial point for soundings is a point over the right abutment, marked by a nail in the floor of the bridge and also marked "zero" with paint. The general direction of the channel is straight for 2,000 feet above and below the station. The velocity is rapid and rather poorly distributed on account of an ice breaker above the middle pier and the variation in width of the channel just above the bridge. The width of the channel at ordinary stages is about 325 feet, broken by one pier. The right bank is high and rocky; the left bank overflows, making the width of the channel from 500 to 600 feet. During the spring floods of 1903 the water overflowed the turnpike.

ht side of the bed of the stream is rocky, but the remainder is nd liable to shift.

ı mark No. 1 is a nail in the top of a red-oak stump, 2½ feet in r, about 60 feet south of the center of the roadbed and about from the river at ordinary stages. Its elevation above the the gage is 12.99 feet. Bench mark No. 2 is a nail in the root ge cottonwood tree, 280 feet south of the bridge and about 80 m the river. Its elevation above the zero of the gage is 11.90 Bench marks Nos. 1 and 2 are on the east side of the river. nark No. 3 is a cross on a large sandstone rock, 70 feet south enter of the roadway and 15 feet west of the water's edge on t bank of the river. Its elevation above the zero of the gage feet.

lrainage area at this station is 5,800 square miles.

bservations at this station during 1904 have been made under ction of E. Johnson, jr., district hydrographer.

rge measurements of Wisconsin River near Necedah, Wis., in 1903 and 1904.

e.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
3.		*Feet.*	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
13 [a]	L. R. Stockman	280	2,617	1.18	5.65	2,840
5 [a]	do	284	2,360	1.26	5.80	2,585
	do	284	2,411	1.09	5.80	2,422
	Johnson and Stockman.		5,405	3.94	11.05	21,280
	L. R. Stockman	220	4,206	2.42	7.55	10,190
	do	309	3,860	1.84	6.50	7,123
	do	281	3,282	1.79	6.00	5,888
	do	316	4,708	4.43	10.50	20,860
	do	302	2,832	2.46	6.20	6,962
r 4	do	276	2,463	2.05	5.30	5,047
2	do	314	3,871	3.23	9.43	12,500
4.						
12 [a]	E. Johnson, jr	286	2,031	1.33	4.60	3,000
	do	317	4,685	3.65	9.60	17,110
	Johnson and Hanna	314	3,717	2.67	7.05	9,921
	E. Johnson, jr	294	3,525	1.66	5.80	5,845
r 21	do	294	1,823	2.08	4.92	3,800
4	F. W. Hanna	449	6,216	5.71	13.35	[b] 34,420

[a] Frozen. [b] Add to this discharge 3,000 second-feet overflow.

Mean daily gage height, in feet, of Wisconsin River near Necedah, Wis., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.[b]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[c]
1	6.0	5.1	5.3	6.60	9.80	11.20	6.30	4.50	4.80	6.60	7.10	4.00
2	5.7	5.2	5.3	6.30	9.20	10.00	6.50	4.70	4.80	6.45	6.90	4.00
3	5.9	5.1	5.3	6.50	8.90	9.10	6.50	4.90	4.80	6.20	6.60	4.00
4	5.6	5.0	5.3	6.90	8.40	8.60	6.30	4.80	4.80	6.10	6.70	.....
5	6.0	5.2	5.3	6.60	8.00	8.40	6.20	4.70	4.30	7.00	6.50	.....
6	6.0	5.2	5.3	6.80	7.80	9.00	6.30	4.70	5.80	6.00	6.40	.....
7	5.9	5.2	5.3	7.00	7.40	9.90	6.00	4.30	6.30	5.90	6.10	.....
8	6.1	5.0	5.4	7.20	.....	10.50	5.90	4.40	5.90	6.30	6.10	.....
9	6.1	5.2	5.4	7.50	7.40	10.50	6.10	4.80	5.70	6.42	6.60	.....
10	6.0	4.9	5.3	7.90	7.90	9.80	6.30	4.90	5.70	6.70	6.10	5.10
11	5.9	5.1	5.3	8.80	9.50	9.00	6.40	5.30	5.30	8.40	5.90	.....
12	5.1	5.2	5.3	9.80	10.50	8.30	6.80	5.30	5.70	10.10	5.20	.....
13	5.1	5.1	5.3	9.80	10.50	7.80	7.10	5.40	5.30	12.00	5.50	.....
14	5.2	5.2	5.2	9.40	9.90	7.50	7.00	5.30	5.50	13.20	5.50	.....
15	5.2	5.1	5.3	8.70	9.40	7.20	6.50	5.30	5.60	13.00	5.60	.....
16	5.3	5.2	5.2	8.30	9.20	6.80	5.90	5.70	4.90	11.90	5.80	.....
17	5.2	5.2	5.2	7.70	9.00	6.90	5.80	5.00	5.20	10.30	5.50	5.50
18	5.1	5.1	5.2	7.30	8.50	6.70	5.50	5.10	5.30	9.40	5.30	.....
19	5.3	5.1	5.1	7.50	8.00	6.50	5.80	5.00	5.90	9.00	4.80	.....
20	5.0	5.0	5.0	7.50	7.70	6.20	5.50	5.00	5.70	8.40	5.00	.....
21	5.2	5.1	4.9	7.70	7.40	5.90	5.60	5.00	4.80	7.90	5.00	.....
22	5.2	5.1	5.0	7.70	7.20	5.80	5.30	4.70	4.90	8.00	5.30	.....
23	5.2	5.1	5.0	7.50	7.10	6.20	5.00	5.10	4.80	8.50	5.40	.....
24	5.1	5.1	4.8	7.60	7.00	5.70	4.80	4.80	4.70	8.50	5.30	6.00
25	5.0	5.2	5.0	8.00	7.50	6.00	4.50	4.90	4.85	8.30	4.90	.....
26	5.1	5.3	5.0	9.30	8.10	5.70	4.80	4.90	4.80	8.30	5.50	.....
27	5.0	5.4	5.2	10.30	9.40	6.10	4.90	5.00	6.70	7.90	5.10	.....
28	5.1	5.2	5.2	10.90	10.60	5.80	4.80	5.90	7.40	7.60	4.80	.....
29	5.2	5.1	5.2	10.70	11.90	6.10	4.70	4.60	7.40	7.50	5.00	.....
30	5.2	.....	5.5	10.50	12.60	6.00	4.80	5.00	7.00	7.40	5.00	.....
31	5.1	.....	5.8	.....	12.30	.....	4.70	4.70	.....	7.00	.....	6.00

[a] River frozen from January 1 to March 31. Ice, average thickness, 10 inches.
[b] Ice conditions April 1 to 12.
[c] Frozen December 4 to 31. Ice 0.1 foot to 2 feet thick.

Rating table for Wisconsin River near Necedah, Wis., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.0	1,800	5.1	4,150	6.4	7,600	9.5	16,900
4.1	2,000	5.2	4,390	6.6	8,200	10.0	18,400
4.2	2,200	5.3	4,630	6.8	8,800	10.5	19,900
4.3	2,400	5.4	4,880	7.0	9,400	11.0	21,400
4.4	2,600	5.5	5,130	7.2	10,000	11.5	23,610
4.5	2,810	5.6	5,380	7.4	10,600	12.0	25,860
4.6	3,020	5.7	5,640	7.6	11,200	12.5	28,230
4.7	3,240	5.8	5,900	7.8	11,800	13.0	30,750
4.8	3,460	5.9	6,170	8.0	12,400	13.5	38,450
4.9	3,690	6.0	6,440	8.5	13,900		
5.0	3,920	6.2	7,010	9.0	15,400		

The foregoing table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1902 to 1904, inclusive. It is well defined tween gage heights 4.5 feet and 10.5 feet. The table has been extended beyond ese limits. From gage height 6.3 feet to 11 feet the rating curve is a tangent, the fference being 300 per tenth. The bank overflows at gage height about 11 feet, hich accounts for the suddenness and magnitude of the increase in difference per nth.

Estimated monthly discharge of Wisconsin River near Necedah, Wis., for 1904.

[Drainage area, 5,800 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
pril	21,100	7,300	12,830	2.21	2.47
ay	28,720	9,400	15,250	2.63	3.03
ne	22,280	5,640	11,350	1.96	2.19
ly	9,700	2,810	5,926	1.02	1.18
ugust	6,170	2,400	3,845	.663	.764
eptember	10,600	2,400	5,227	.901	1.01
ctober	33,830	6,170	13,590	2.34	2.70
ovember	9,700	3,460	5,698	.982	1.10

ROCK RIVER DRAINAGE BASIN.

Rock River, with its tributaries, Pecatonica and Kishwaukee rivers, one of the most important streams in Illinois. It rises in the southastern part of Wisconsin, flows south and southwest, and enters the Iississippi just below Rock Island, Ill. This river has much power lready developed along its course, and there are several points at hich large water-power plants could be situated. It is also to be sed as a feeder for the Hennepin canal. The United States Geologal Survey has maintained a station on this river at Rockton, Ill., elow the mouth of Pecatonica River during the year of 1904.

ROCK RIVER AT ROCKTON, ILL.

This station was established May 13, 1903, by E. Johnson, jr., ssisted by L. R. Stockman. It is located at the village highway ridge, one-half mile from the Chicago, Milwaukee and St. Paul Railad station, 1 mile below the dam and three-fourths of a mile below e junction of Pecatonica River with Rock River. There are small lands a short distance above and immediately below the station. he chain gage is located on the first span from the left end of the ridge, on the downstream side. The gage is read twice each day by

O. T. Bartholomew. The length from end of weight to marker is 26. feet. Discharge measurements are made from the upstream side the five-span highway bridge to which the gage is attached. The tial point for soundings is the face of the abutment on the left en the bridge. The channel is straight for 2,000 feet above and 1. feet below the station. Both banks are high and will not overfl The channel is about 565 feet wide between bridge abutments an broken by four piers. The bed of the stream is composed of s rocks and gravel.

Bench mark No. 1 is a hammered cross on the top stone of the abutment, about 1 foot from the bridge shoe and 1 foot from the s edge. Its elevation above gage datum is 16.85 feet. Bench n No. 2 is the top of the west end of the south rail of the railroad tr 250 feet north of the north end of the bridge, at a point where sidewalk on the west side of the street crosses the track. Its el tion above gage datum is 16.49 feet.

The observations at this station during 1904 have been made u the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Rock River at Rockton, Ill., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	I ch
1903.		*Feet.*	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec*
May 13	L. R. Stockman				2.90	
June 30	A. C. Lootz	296	547	2.74	2.30	
August 18	L. R. Stockman	490	1,352	3.41	4.07	
September 4	F. W. Hanna		1,352	3.41	4.08	
October 9	do	504	1,998	3.74	5.35	
November 9	do	453	831	[a] 3.46	2.85	
December 10[b]	do	367	743	3.21	2.60	
1904.						
January 16[c]	F. W. Hanna	380	662	2.25	2.90	1
March 14	do	509	4,031	2.77	9.30	11
March 25	do	509	5,744	4.34	12.32	24
April 18	do	504	2,361	3.90	5.91	9
June 23	do	378	660	3.18	2.50	2
July 7	do	389	645	2.93	2.38	1
August 30	do	381	674	3.02	2.45	2
September 23	do	408	739	3.19	2.65	2
October 26	do	426	759	3.13	2.70	2
November 9	do	397	695	3.09	2.50	2

[a] High wind; velocity doubtful. [b] Partly frozen. [c] Ice 0.59 foot thick.

Mean daily gage height, in feet, of Rock River at Rockton, Ill., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[a]
.....	2.90	2.90	3.80	10.65	4.53	3.68	2.20	2.10	2.15	3.50	2.65	2.20
.....	2.90	2.90	3.95	9.61	4.50	3.68	2.20	1.90	2.15	3.25	2.60	2.15
.....	2.90	3.10	6.09	8.85	4.30	3.51	2.25	1.80	2.20	3.15	2.45	2.20
.....	3.00	3.20	6.72	8.37	4.18	3.00	2.20	1.80	2.12	3.00	2.50	2.20
.....	2.90	3.00	6.83	8.06	4.05	3.20	2.15	1.80	2.30	2.85	2.45	2.25
.....	2.80	2.80	6.60	7.85	4.01	3.10	2.15	1.90	2.60	3.20	2.45	2.20
.....	2.90	4.50	7.45	7.60	4.00	3.10	2.30	1.95	2.45	3.25	2.25	2.20
.....	2.90	5.50	9.92	7.60	4.18	3.11	2.40	1.90	2.35	3.10	2.45	2.20
.....	2.90	5.90	10.80	7.60	4.50	3.00	2.50	1.82	2.30	2.75	.....	2.20
.....	3.00	6.10	11.12	7.60	4.85	2.95	2.46	1.90	2.31	3.00	2.45	2.20
.....	2.60	6.00	11.10	7.61	4.79	2.95	2.35	1.85	2.30	3.40	2.45	2.20
.....	2.90	5.80	10.90	7.41	4.76	2.85	2.35	1.75	2.20	3.81	2.50	2.20
.....	2.90	5.50	10.30	7.10	4.81	2.80	2.40	1.80	2.20	4.25	2.40	2.40
.....	3.00	4.70	9.33	6.83	4.81	2.75	2.25	1.70	2.26	4.25	2.20	2.45
.....	2.80	4.10	8.85	6.50	4.91	2.70	2.20	1.85	2.20	4.50	2.30	2.70
.....	2.90	3.90	8.00	6.40	4.95	2.60	2.13	1.55	2.15	3.80	2.45	2.85
.....	3.00	3.80	6.34	6.20	4.99	2.62	2.00	1.75	2.10	3.30	2.45	2.70
.....	2.70	3.80	5.50	5.91	4.81	2.55	2.10	1.90	2.20	3.15	2.35	3.00
.....	3.00	3.60	4.90	5.79	4.80	2.65	2.10	1.75	2.90	3.50	2.45	2.65
.....	3.00	3.60	8.35	5.60	4.68	2.50	2.10	1.90	4.00	2.90	2.40	2.90
.....	3.10	3.70	8.35	5.48	4.60	2.50	2.00	1.95	3.80	2.75	2.20	2.80
.....	3.10	3.60	12.75	5.35	4.48	2.50	2.00	2.50	3.25	2.70	2.30	2.70
.....	3.20	3.50	13.23	5.16	4.32	2.50	2.00	2.80	2.80	2.70	2.30	2.45
.....	3.30	3.30	12.05	5.18	4.28	2.45	2.00	3.00	2.55	2.75	2.20	2.50
.....	3.20	3.50	12.25	5.53	4.31	2.40	1.75	3.10	2.35	2.70	2.30	2.50
.....	3.30	3.50	12.55	5.55	4.18	2.35	2.10	2.70	2.65	2.65	2.40	2.50
.....	3.30	3.60	12.40	5.31	4.10	2.15	2.50	2.30	3.35	2.65	2.20	3.00
.....	3.10	3.60	12.30	5.04	3.90	2.20	2.10	2.40	4.20	2.70	2.20	4.20
.....	3.00	3.80	11.85	4.80	3.85	2.20	2.00	2.10	4.12	2.60	2.20	5.10
.....	2.90	.....	11.45	4.63	3.79	2.20	2.00	2.20	3.65	2.55	2.30	5.15
.....	2.90	.....	11.16	.....	3.80	.....	2.00	2.30	.....	2.75	.....	4.60

[a] River partially frozen January 1 to March 27, and December 13 to 31.

Rating table for Rock River at Rockton, Ill., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.5	810	2.8	2,470	4.2	4,940	8.0	14,020
1.6	910	2.9	2,620	4.4	5,345	8.5	15,270
1.7	1,015	3.0	2,775	4.6	5,760	9.0	16,520
1.8	1,125	3.1	2,935	4.8	6,180	9.5	17,770
1.9	1,235	3.2	3,105	5.0	6,620	10.0	19,020
2.0	1,350	3.3	3,280	5.2	7,070	10.5	20,270
2.1	1,470	3.4	3,455	5.4	7,540	11.0	21,520
2.2	1,600	3.5	3,635	5.6	8,020	11.5	22,770
2.3	1,740	3.6	3,815	5.8	8,520	12.0	24,020
2.4	1,880	3.7	3,995	6.0	9,020	13.0	26,520
2.5	2,025	3.8	4,180	6.5	10,270		
2.6	2,170	3.9	4,365	7.0	11,520		
2.7	2,320	4.0	4,555	7.5	12,770		

The preceding table is applicable only for open-channel conditions. It is based upon 17 discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.4 feet and 6 feet. One flood measurement at 12.32 fixes the upper part of the curve. The table has been extended beyond these limits. Above gage height 5.6 feet the rating curve is a tangent, the difference being 250 per tenth.

Estimated monthly discharge of Rock River at Rockton, Ill., for 1904.

[Drainage area, 6,150 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	3,280	2,170	2,747	0.446	0.514
February [a]	9,270	2,470	4,762	.774	.835
March [a]	27,100	4,180	17,220	2.80	3.23
April	20,640	5,823	10,810	1.76	1.96
May	6,598	4,162	5,405	.879	1.01
June	3,959	1,535	2,432	.395	.441
July	2,025	1,070	1,570	.255	.294
August	2,935	860	1,471	.239	.276
September	4,940	1,470	2,344	.381	.425
October	5,550	2,098	3,058	.497	.573
November	2,245	1,600	1,847	.300	.335
December [a]	6,955	1,535	2,514	.409	.472
The year	27,100	860	4,682	.761	10.37

[a] Daily discharges January, February, March, and December applied as for open channel.

ILLINOIS RIVER DRAINAGE BASIN.

Illinois River is formed by the junction of Kankakee and Desplaines rivers at a point near Minooka, Grundy County, Ill. Its principal tributaries are Fox and Spoon rivers from the west and Vermilion and Sangamon rivers from the east. During 1904 gaging stations have been maintained in the Illinois River drainage basin at Peoria, Ottawa, and Minooka on the Illinois, and on the Desplaines at Channahon above the mouth of Jackson Creek.

The drainage areas at the points where stations have been maintained are as follows:

Drainage areas in Illinois basin at gaging stations.

	Square miles.
ILLINOIS RIVER.	
Peoria	13,250
Minooka	6,480
Ottawa	10,100
DESPLAINES RIVER.	
Jackson Creek	1,170

ILLINOIS RIVER NEAR MINOOKA, ILL.

This station was established November 7, 1902, by E. H. Heilbron, determine the flow of Kankakee River. It is 6 miles south of nooka, Ill., and 2½ miles below the mouth of Kankakee River at the gin, Joliet and Eastern Railroad bridge. The gage is a vertical rod tened to the center pier of the bridge. It is read twice daily by A. Lyons. Discharge measurements are made from the bridge. e initial point for soundings is an oak hub about 4 feet north of the rth side of the railroad pumping station. The channel is straight 1,000 feet above the station and 2,000 feet below. The width at linary stages is 560 feet, with a maximum depth of 12 feet. The w is moderately rapid, but is sluggish at low stages. The width at gh water is about 1,000 feet. The right bank is low and liable to erflow; the left bank is high. The bed of the stream is of gravel d is shifting on the north side.

The bench mark is a cut in the stone on the south abutment of the gin, Joliet and Eastern Railroad bridge. It is marked S. D. ⊡ P. B. M. elevation is 85.030 feet above the Hennepin datum and 66.764 feet low the Chicago city datum. The gage is set with its zero at the ne elevation as the zero of the Chicago datum, thus giving directly e elevation of the river surface below this datum.

The observations at this station during 1904 have been made under e direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Illinois River near Minooka, Ill., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.[a]	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
rch 15	E. H. Heilbron	630	9,182	2.80	86.84	25,680
ril 19	do	594	6,604	2.04	91.12	13,480
y 10	do	553	4,893	1.03	94.10	7,393
ly 12	do	541	4,556	1.64	93.83	7,465
gust 31	do	560	3,856	1.83	93.99	7,044
ptember 26	Johnson and Hanna	520	4,199	1.75	94.10	7,319
tober 24	do	530	4,317	1.78	94.10	7,673
vember 11	F. W. Hanna	513	4,466	1.70	94.15	7,596
1904.						
arch 26	E. H. Heilbron	948	14,800	4.40	78.50	64,880
arch 27	do	682	12,980	3.85	79.98	50,920
pril 3	do	622	11,230	3.30	82.40	37,120
pril 17	do	580	6,937	2.44	89.63	16,930
pril 26	do	584	7,740	2.62	88.15	20,310
ay 2	do	560	6,454	2.46	90.51	15,890
ay 19	do	565	5,140	1.91	93.00	9,845

[a] *All gage heights* are negative, being below Chicago datum.

Mean daily gage height, in feet, of Illinois River near Minooka, Ill., for 1904.[a]

Day.	Jan.[b]	Feb.[b]	Mar.[b]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	91.89	90.20	83.71	81.60	90.00	92.76	94.65	94.65	.....	93.75	95.05	94.65
2	91.83	90.79	83.21	81.50	90.53	92.88	94.59	94.70	.....	93.75	95.05	94.60
3	91.79	90.80	81.36	82.37	91.02	92.95	94.65	94.70	94.58	94.20	94.92	94.60
4	91.85	90.80	81.75	83.17	91.42	93.10	.....	94.75	94.75	94.40	94.53	94.55
5	92.00	90.98	82.52	84.02	91.68	93.11	94.44	94.70	94.75	94.55	94.55	94.32
6	91.94	90.08	83.38	84.97	91.85	93.30	94.42	94.58	94.75	94.70	95.00	94.40
7	91.79	85.36	82.68	85.80	91.98	93.42	94.48	94.70	94.80	94.80	94.57	94.27
8	91.80	85.10	82.78	86.20	92.11	93.48	94.55	94.70	94.75	94.90	94.75	94.27
9	91.75	85.95	84.90	86.12	91.78	93.90	93.98	94.75	95.00	94.80	94.55	94.23
10	91.62	86.14	85.35	86.27	91.60	94.10	93.82	94.75	95.08	95.00	94.53	95.05
11	91.48	86.68	85.72	86.47	91.74	94.24	(c)	94.80	95.05	94.75	94.45	94.50
12	91.41	87.64	86.56	86.85	91.92	94.26	.....	94.70	95.00	94.90	94.55	94.25
13	91.81	88.49	87.58	87.41	92.25	94.36	.....	94.75	95.05	94.80	94.47	94.40
14	92.50	88.92	87.85	87.98	92.45	94.88	.....	94.87	95.15	94.95	94.48	94.35
15	92.09	89.67	88.48	88.42	92.56	94.68	.....	94.80	95.20	94.40	94.37	.....
16	91.87	90.08	88.52	89.17	92.68	94.27	.....	94.77	95.40	94.35	94.47	.....
17	91.89	90.12	88.54	89.65	92.90	94.76	.....	94.75	95.20	94.35	94.43	.....
18	91.80	90.45	88.51	90.02	92.92	94.65	.....	94.70	93.25	94.85	94.45	.....
19	91.91	90.76	85.21	90.30	93.03	94.60	.....	94.80	94.15	95.00	94.47	.....
20	91.49	90.67	82.80	90.85	93.12	94.72	.....	(c)	94.90	95.00	94.48	.....
21	86.95	90.70	83.37	91.15	93.29	94.68	.....	.....	95.10	95.05	94.52	.....
22	83.35	90.90	82.01	91.35	93.39	94.55	.....	.....	95.10	94.90	94.52	.....
23	83.40	90.95	80.66	91.48	93.34	94.90	.....	.....	95.20	95.10	94.48	.....
24	84.90	90.88	81.21	90.60	93.47	95.02	.....	.....	95.05	95.10	94.53	.....
25	85.65	90.89	79.52	90.42	93.44	94.92	.....	.....	95.00	95.00	94.45	.....
26	86.14	90.81	78.50	88.82	93.46	94.85	.....	.....	94.55	95.00	94.45	.....
27	87.24	90.62	80.02	87.08	93.55	95.00	.....	.....	94.70	95.00	95.20	.....
28	88.38	90.53	81.25	87.50	93.51	94.84	.....	.....	93.95	94.05	95.30	.....
29	89.11	88.65	82.24	88.27	93.50	94.76	.....	.....	92.85	95.07	95.07	.....
30	89.45	.....	83.12	89.22	93.28	94.62	.....	.....	93.60	94.95	94.95	.....
31	89.73	.....	82.94	.....	92.96	.....	.....	.....	.....	95.05	.....	.....

[a] All gage heights here given of this river are below the Chicago datum.
[b] River frozen January 1 to about March 20. Ice varies in thickness from 0.5 to 2 feet.
[c] Observer absent.

Rating table for Illinois River near Minooka, Ill., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
95.0	6,320	93.5	8,735	91.0	13,530	86.5	24,590
94.9	6,470	93.4	8,905	90.8	13,950	86.0	26,040
94.8	6,620	93.3	9,075	90.6	14,370	85.5	27,550
94.7	6,770	93.2	9,245	90.4	14,800	85.0	29,120
94.6	6,925	93.1	9,415	90.2	15,240	84.5	30,750
94.5	7,080	93.0	9,590	90.0	15,680	84.0	32,440
94.4	7,240	92.8	9,950	89.8	16,120	83.5	34,200
94.3	7,400	92.6	10,330	89.6	16,560	83.0	36,000
94.2	7,560	92.4	10,710	89.4	17,020	82.5	37,880
94.1	7,720	92.2	11,110	89.2	17,480	82.0	39,820
94.0	7,885	92.0	11,510	89.0	17,960	81.0	44,010
93.9	8,055	91.8	11,910	88.5	19,210	80.0	49,910
93.8	8,225	91.6	12,310	88.0	20,510	79.0	59,010
93.7	8,395	91.4	12,710	87.5	21,820		
93.6	8,565	91.2	13,110	87.0	23,180		

eding table is applicable only for open-channel conditions. It is based ischarge measurements made during 1903 and 1904. It is well defined age heights −94 feet and −87 feet. All gage heights are negative, being ago datum. The table has been extended beyond these limits. Above t −79.5 feet the rating curve is a tangent, the difference being 1,200 per

mated monthly discharge of Illinois River near Minooka, Ill., for 1904.

[Drainage area, 6,480 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
31	64,810	34,670	44,130	6.81	2.79
	41,860	12,510	22,610	3.49	3.89
	15,680	8,565	10,660	1.65	1.90
	9,950	6,320	7,559	1.17	1.30
	8,225	6,925	7,245	1.12	.417
19	6,925	6,470	6,699	1.03	.728
r 3–30	9,950	5,720	6,772	1.05	1.09
	8,225	6,170	6,735	1.04	1.20
	7,240	5,870	6,848	1.06	1.18
1–14	7,560	6,320	7,164	1.11	.578

ILLINOIS RIVER AT OTTAWA, ILL.

tation was established November 11, 1902, by E. H. Heilbron. ated at the Chicago, Burlington and Quincy Railroad bridge, et below the mouth of Fox River and 200 feet below the high- lge leading to the main street of Ottawa, Ill. A standard ıge was established November 1, 1903, to replace the old ver- ge and was made to read the same as the original gage. The f chain from the end of the weight to the marker is 37.42 feet. e was read twice each day by D. C. Woods. Discharge meas- s were made from the upper side of the railroad bridge, to he gage is attached. The initial point for soundings was the ne of the group of nails driven into the cap at the left end of tlework, south of the main bridge structure. The channel is for about 2,000 feet above and below the station and has a etween abutments of 650 feet, broken by three piers. The ordinary stages is about 13 feet. The railroad embankments rt of the banks of this river. The bed of the stream is com- f gravel, which is somewhat shifting. The flow is somewhat ı at low stages.

ı mark No. 1 is the top of the coping stone at the east end of pier from the north end of the railroad bridge. The point is

marked "U. S." Its elevation is 48.638 feet above the Henn datum, and 103.156 feet below the Chicago datum. Bench mark N is a cut in the batter on the coign, 3 feet above ground, at the end of the south pier of the railroad bridge. The gage is set wit zero at the same elevation as the zero of the Chicago datum, giving directly the elevation of the river surface below this da

The observations at this station during 1904 have been made u the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Illinois River at Ottawa, Ill., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.[a]	c
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sc*
March 18	E. H. Heilbron	650	6,817	4.53	122.98	
April 5	do	600	4,738	3.71	126.25	
April 28	do	610	5,001	3.67	126.07	
May 12	do	545	3,501	3.32	128.42	
July 8	do	480	2,847	2.65	129.54	
August 23	E. Johnson, jr	660	2,924	2.62	129.57	
September 25	Johnson and Hanna	560	3,466	3.35	128.35	
October 12	do	553	3,609	3.75	127.88	
November 12	F. W. Hanna	525	3,090	2.88	129.01	
December 12[b]	do	550	4,424	1.54	126.42	
1904.						
March 30	E. H. Heilbron	745	10,220	4.56	118.30	
April 2	do	750	10,990	4.96	117.30	
April 17	do	626	5,164	3.62	125.40	
April 26	do	652	6,136	4.20	123.90	
May 2	do	608	4,775	3.90	125.80	
May 19	do	541	3,583	2.89	128.1	

[a] Below Chicago datum. [b] Ice jam.

Mean daily gage height,[a] in feet, Illinois River at Ottawa, Ill., for 1904.

Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.
1	127.28	124.20	9	126.82	120.00	17	127.02	124.60	25	120.00
2	127.22	124.20	10	126.80	120.30	18	126.95	124.80	26	120.50
3	127.12	124.20	11	126.88	120.70	19	126.90	124.10	27	121.00
4	126.90	124.20	12	126.85	121.30	20	125.30	124.10	28	122.10
5	126.82	124.20	13	126.90	122.70	21	121.10	124.11	29	122.22
6	126.80	123.45	14	126.98	123.10	22	118.60	.....	30	123.20
7	126.80	120.60	15	127.24	123.60	23	118.80	.....	31	123.92
8	126.85	118.60	16	127.32	123.80	24	119.45	.....		

[a] The gage heights here given of this river are below the Chicago datum and were recor the cards as minus (−).

ILLINOIS RIVER NEAR PEORIA, ILL.

This station was established March 10, 1903, by E. H. Heilbron. It is located on the Peoria and Pekin Union Railroad bridge over the Illinois River, 1½ miles southwest of Peoria, Ill., and can be reached by street cars. The gage is a plain staff graduated to feet and inches and fastened to the central pier of the bridge. It is read twice daily by the draw tender of the bridge, P. A. Blumb. The measurements are taken from the bridge, and the initial point for sounding is on the right bank. The river is straight for 3,000 feet above and 2,000 feet below the station and has a width of about 1,000 feet, broken by six piers. The section is deep and the flow sluggish. The bed of the stream is composed of gravel and silt. The right bank is high, and there is a railroad embankment along this shore. The left bank is low and liable to overflow.

The bench mark is the southwest corner of the top stone of the west abutment of the bridge; elevation, 125.722 feet below the Chicago datum. The gage at this point has for its zero a point 153.814 feet below the Chicago city datum. The gage reads up from this point, and in order to obtain the height of the river, referred to the Chicago datum, it is necessary to subtract the gage reading from 153.814 feet.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Illinois River near Peoria, Ill., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second ft.*
January 30[a]	E. H. Heilbron	943	14,870	1.58	16.30	21,120
February 4[a]	do	933	13,640	1.20	15.42	16,300
February 14	do	955	14,810	1.50	16.30	21,780
March 3	do	953	13,300	1.75	14.94	23,280
March 28	do	951	19,980	2.93	21.83	58,370
March 31	do	953	20,250	2.21	21.48	[b] 44,810
April 2	do	953	19,310	2.17	21.17	[b] 41,930
April 7	do	953	19,030	2.71	20.12	51,560
April 9	do	953	18,570	2.87	19.66	52,370
April 16	do	953	16,870	2.46	18.00	41,460
April 24	do	946	14,080	1.96	15.70	27,590
May 1	do	952	14,460	2.16	16.00	31,310
May 18	do	950	11,830	1.43	13.21	16,910

[a] Partly frozen. [b] Questionable.

Mean daily gage height, in feet, of Illinois River near Peoria, Ill., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	10.12	15.86	14.17	21.29	15.96	11.67	8.42	8.46	8.04	9.58	7.83	[illegible]
2	10.25	15.71	14.37	21.17	15.75	11.54	8.04	8.42	7.96	9.67	7.83	[illegible]
3	10.25	15.54	14.79	21.08	15.54	11.46	7.88	8.33	8.00	9.63	7.83	[illegible]
4	10.25	15.37	15.54	20.87	15.42	11.62	7.71	8.25	7.96	9.50	7.75	[illegible]
5	10.25	15.21	16.12	20.62	15.12	11.38	.....	8.21	7.83	9.58	7.79	[illegible]
6	10.17	15.33	16.67	20.46	14.87	11.29	8.04	8.12	7.78	9.46	7.75	[illegible]
7	10.17	15.50	16.87	20.12	14.75	11.17	7.95	8.00	7.75	9.29	7.67	[illegible]
8	10.17	15.62	17.04	19.79	14.54	11.17	7.92	7.92	7.63	9.17	7.75	[illegible]
9	10.17	15.92	17.25	19.67	14.37	11.38	8.12	7.75	7.46	9.17	7.75	[illegible]
10	10.17	16.29	17.67	19.46	14.29	11.46	8.12	7.83	7.38	9.08	7.75	[illegible]
11	10.17	16.42	17.87	19.21	14.04	11.25	8.16	7.75	7.58	9.08	7.75	[illegible]
12	10.21	16.42	17.92	19.08	13.87	11.04	8.42	7.71	7.42	9.04	7.71	[illegible]
13	10.25	16.42	17.92	18.79	13.83	10.87	8.42	7.54	7.33	9.00	7.83	[illegible]
14	10.25	16.29	17.79	18.50	13.79	10.71	8.58	7.37	7.33	8.88	7.71	[illegible]
15	10.25	16.04	17.54	18.17	13.29	10.54	8.71	7.54	7.33	8.75	7.67	[illegible]
16	10.17	15.79	17.29	17.96	13.46	10.38	8.67	7.50	7.29	8.66	7.75	[illegible]
17	10.17	15.54	17.13	17.50	13.37	10.16	8.67	7.50	7.25	8.58	7.75	[illegible]
18	10.08	15.33	16.87	17.21	13.21	9.88	8.67	7.42	7.33	8.50	7.83	[illegible]
19	10.08	15.13	16.87	16.96	13.17	9.75	8.62	7.42	7.54	8.42	7.79	[illegible]
20	10.46	14.85	17.25	16.58	12.88	9.46	8.54	7.84	7.75	8.33	7.88	[illegible]
21	12.21	14.70	17.83	16.25	12.71	9.41	8.42	7.58	7.79	8.37	7.83	[illegible]
22	13.04	14.54	18.83	15.87	12.42	9.29	8.29	8.12	7.75	8.42	7.83	[illegible]
23	13.54	14.36	19.46	15.58	12.50	9.08	8.12	8.21	7.62	8.33	7.79	[illegible]
24	14.46	14.20	20.04	15.58	12.38	8.83	8.04	8.29	7.66	8.25	7.83	[illegible]
25	15.33	14.00	20.62	15.75	12.13	8.83	7.88	8.42	7.83	8.20	7.83	[illegible]
26	15.91	13.80	21.12	15.92	12.08	8.71	7.79	8.42	8.94	8.20	7.83	[illegible]
27	16.08	13.60	21.67	15.87	11.96	8.54	7.75	8.42	9.63	8.08	7.83	[illegible]
28	16.29	13.58	21.83	15.87	11.79	8.38	7.75	8.33	9.44	8.00	7.58	[illegible]
29	16.33	14.00	21.75	15.54	11.67	8.21	7.62	8.25	9.33	8.00	7.58	[illegible]
30	16.25	.....	21.62	16.00	11.75	8.13	7.54	8.25	9.54	8.00	7.58	[illegible]
31	16.04	.....	21.46	.....	11.67	.....	8.84	8.12	.....	7.92	.....	[illegible]

[a] River frozen over from January 1 to March 20, 1904. Average thickness 0.1 foot to 1 foot.
[b] Ice December 13 to 31.

DESPLAINES RIVER ABOVE JACKSON CREEK, NEAR CHANNAHON, ILL.

This station was established October 23, 1902, by E. H. Heilbron. It is located just above the mouth of Jackson Creek, 2½ miles southwest of Millsdale, Ill. The gage is a vertical staff graduated to feet and tenths, and is read daily by Ruth Alexander. The measurements are taken from a cable and boat. The initial point for sounding is a red hub driven in the ground on the left bank near the end of the cable. The channel is straight for about 3,000 feet both above and below the station and has a width of 360 feet and a maximum depth of 16 feet at ordinary stages. Its flow is moderately rapid. Both banks of the stream are low and liable to overflow, but a few feet from the top of the banks on either side are high ridges, which never overflow. Measurements can be made at all stages. The bed of the stream is gravel.

nch mark is the top of a red oak hub (the initial point for) driven in the bluff between Jackson Creek and the south Desplaines River. It is about 300 feet west of the west line ;, T. 37 N., R. 9 E., third principal meridian, and is on the ıed by George Alexander. Elevation, 64.262 feet below the datum. The gage is set with its zero at the same elevation ro of the Chicago datum, thus giving directly the elevation of surface below this datum. This station was located to give arge of upper Desplaines River.

cessively large discharge at this station is due to the fact that 4,000 and 5,000 second-feet are constantly being diverted from ·higan into Desplaines River a short distance above this gaging

servations at this station during 1904 have been made under tion of E. Johnson, jr., district hydrographer.

neasurements of Desplaines River above the mouth of Jackson Creek, near Channahon, Ill., in 1904.

	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
[a]	E. H. Heilbron	375	5,133	1.70	78.00	8,535
[a]	do	440	6,468	1.09	75.20	7,062
	do	440	6,240	2.62	76.06	16,380
	do	437	6,324	2.57	76.10	16,230
	do	430	6,057	2.56	76.32	15,530
	do	465	6,654	2.61	74.80	17,340
	do	477	6,813	2.63	74.60	17,940
	do	485	7,112	2.82	74.10	20,080
	do	450	6,386	2.48	75.64	15,820
	do	384	5,071	2.09	78.80	10,610
	do	360	3,936	1.40	81.80	5,548

[a] Partly frozen. Ice gorge below Kankakee River.

heights are negative, being below Chicago datum.

Mean daily gage height,[a] in feet, of Des Plaines River above the mouth of Jacks near Channahon, Ill., for 1904.

Day.	Jan.[b]	Feb.[b]	Mar.[b]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	N
1	81.01	78.47	76.65	77.78	82.59	82.92	83.29	82.98	82.98	83.53	83
2	80.76	78.85	76.96	78.04	82.61	82.88	83.38	83.20	83.02	83.56	83
3	80.60	78.80	75.17	78.91	82.65	82.91	83.22	83.10	83.05	83.60	83
4	80.62	78.97	76.65	79.68	82.77	82.95	83.15	83.11	83.10	83.64	83
5	80.84	78.56	77.96	80.18	82.74	82.90	83.26	83.05	83.08	83.60	83
6	80.79	78.15	78.13	80.45	82.59	82.95	83.30	83.08	83.16	83.62	83
7	80.98	75.55	76.91	80.90	82.65	82.80	83.20	83.02	82.96	83.68	83
8	81.58	75.02	77.96	80.70	82.68	83.00	83.10	83.11	83.02	83.50	83
9	81.20	76.61	78.52	81.16	82.58	83.38	83.11	83.10	83.65	83.62	83
10	80.41	76.89	78.52	81.10	82.60	83.42	83.36	83.05	83.65	83.58	82
11	80.51	77.44	78.46	81.22	82.70	83.48	83.10	83.12	83.62	84.15	83
12	90.60	78.08	78.78	81.32	82.78	83.50	83.10	83.08	83.72	83.55	83
13	81.04	78.53	78.78	81.70	82.86	83.50	83.19	83.04	83.62	83.64	82
14	82.28	78.75	78.74	81.78	82.75	84.02	83.18	83.36	83.22	83.56	83
15	80.63	79.38	78.84	81.85	82.69	83.85	83.15	83.24	83.67	83.00	82
16	80.43	79.50	79.78	82.35	82.70	83.48	83.05	83.08	83.90	83.00	83
17	80.68	79.68	80.70	82.38	82.65	83.80	83.05	83.18	83.70	82.97	82
18	80.70	79.75	80.96	82.44	82.60	83.68	83.16	83.31	82.87	83.60	83
19	80.82	79.78	79.42	82.35	82.69	83.70	83.22	83.04	82.95	83.60	83
20	80.50	79.90	78.47	82.56	82.76	83.78	83.18	83.72	83.68	83.82	82
21	78.16	79.85	78.55	82.58	82.87	83.75	83.11	83.92	83.71	83.88	83
22	75.06	79.95	76.31	82.62	82.97	83.65	83.00	83.05	83.86	83.53	83
23	75.30	79.95	75.27	82.68	83.25	83.82	83.07	83.10	83.80	83.87	83
24	75.54	79.95	76.15	81.44	83.15	84.00	83.14	82.91	83.80	83.77	83
25	75.52	80.20	74.37	81.38	82.95	83.90	83.02	82.88	83.70	83.89	83
26	75.86	80.20	74.30	81.05	82.95	83.82	83.05	82.90	83.60	83.88	83
27	76.74	80.17	75.95	81.40	83.00	83.89	82.95	82.95	83.68	83.87	84
28	77.37	80.15	76.92	81.79	82.98	83.57	83.00	83.00	83.01	83.83	84
29	77.74	78.46	77.85	82.13	83.00	83.53	83.00	82.92	83.02	84.50	84
30	77.92	.....	78.86	82.41	82.72	83.20	83.00	82.90	83.48	83.87	83
31	78.20	.....	78.60	.....	82.90	.....	82.98	83.00	.....	83.83	...

[a] All gage heights of this station are negative (−), being below Chicago datum.
[b] Ice conditions January 1 to about March 15.
[c] Frozen December 11 to 31.

Rating table for Des Plaines River above the mouth of Jackson Creek, near Channahon, Ill., from March 14, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
84.0	4,480	82.8	5,580	81.2	7,580	78.5	11,620
83.9	4,545	82.7	5,700	81.0	7,840	78.0	12,470
83.8	4,615	82.6	5,820	80.8	8,100	77.5	13,320
83.7	4,690	82.5	5,940	80.6	8,370	77.0	14,170
83.6	4,770	82.4	6,060	80.4	8,650	76.5	15,070
83.5	4,855	82.3	6,180	80.2	8,930	76.0	15,970
83.4	4,945	82.2	6,300	80.0	9,210	75.5	16,870
83.3	5,040	82.1	6,420	79.8	9,510	75.0	17,770
83.2	5,140	82.0	6,545	79.6	9,830	74.0	19,570
83.1	5,245	81.8	6,800	79.4	10,150	73.0	21,370
83.0	5,355	81.6	7,060	79.2	10,470		
82.9	5,465	81.4	7,320	79.0	10,790		

The above table is applicable only for open-channel conditions. It is based upon 21 discharge measurements made during 1903 and 1904, inclusive. It is not well defined. All gage heights are negative, being below Chicago datum. Above gage height −77.0 feet the rating curve is a tangent, the difference being 180 per tenth.

Estimated monthly discharge of Des Plaines River above the mouth of Jackson Creek, near Channahon, Ill., for 1903 and 1904.

[Drainage area, 1,170 square miles.]

Month.	1903.			1904.		
	Discharge in second feet.			Discharge in second-feet.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
March 16 to 31	9,990	6,180	7,559	19,030	7,892	13,180
April	10,790	5,090	6,844	12,840	5,724	7,565
May	5,557	5,030	5,235	5,904	5,090	5,604
June	5,580	5,192	5,420	5,580	4,468	4,919
July	6,300	5,234	5,460	5,410	4,964	5,215
August	5,820	4,992	5,333	5,488	4,532	5,247
September	8,165	5,182	6,001	5,500	4,545	4,967
October	5,880	5,322	5,554	5,388	4,200	4,740
November	6,420	4,200	5,483	5,557	4,250	5,098
December	8,426	4,754	6,489	6,084	4,480	5,443

Miscellaneous discharge measurements of Illinois River at highway bridge, near Havana, Ill., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-ft.*
March 28	E. H. Heilbron	1,034	15,990	4.65	19.40	74,310
March 29	do	1,034	16,260	4.68	19.70	76,070
April 1	do	1,035	16,410	4.90	19.90	80,300
April 16	do	1,035	13,830	3.58	17.20	49,530
April 18	do	726	13,160	4.41	18.95	[a] 58,050
April 25	do	1,034	11,270	3.29	14.90	37,100
May 1	do	1,034	11,270	3.10	14.80	34,950

[a] Channel obstructed by drift.

ALLEGHENY RIVER DRAINAGE BASIN.

Allegheny River, which, with the Monongahela, forms the Ohio at Pittsburg, rises in northern Pennsylvania, flows north into the State of New York, then flows south through western Pennsylvania. The headwaters have an elevation of about 2,500 feet, and join those of Genesee River on the north and of the Susquehanna on the east. The total length from the source to the mouth at Pittsburg is about 300 miles, 47 of which are in the State of New York. The principal facts concerning this river have been given in a report by Mr. George M. Lehman, assistant engineer, contained in House Document No. 72, Fifty-fifth Congress, third session. Although this river drains a large area, much of which is of an elevated and even mountainous character, yet it is of comparatively small value for water power. The total fall in 255 miles between Olean, N. Y., and the mouth is only 725 feet, or an average of less than 3 feet per mile. This descent is accomplished without abrupt pitches and even with few rapids having a fall of much consequence. Between Olean and the mouth of Kiskiminitas River, 30 miles above Pittsburg, the greatest amount of natural fall on any ripple less than a thousand feet long is 3.9 in 850 feet at Pattersons Falls. During about half of the year the river is navigable for small steamers to Franklin, 123 miles above Pittsburg.

The drainage areas of the river and its chief tributaries are given in he following table:

River.	Locality.	Drainage area.
		Sq. miles.
llegheny	Mouth	11,100
Do	Kittanning	8,700
Do	Above mouth of French Creek	5,950
Do	Franklin	5,670
Do	Warren	3,050
Do	Salamanca	1,560
Do	Olean, below Olean Creek	1,100
Do	Port Allegheny	220
onewago Creek	Mouth	935
onesta Creek	do	458
rench Creek	do	1,180
larion	do	1,175
ed Bank Creek	do	526
ahoning Creek	do	397
iskiminitas	do	1,846
Do	Salina	1,770
lacklick Creek	Blacklick	403

During 1904 the United States Geological Survey has maintained gaging stations in this basin at the following places: Allegheny River at Redhouse, N. Y.; Kittanning, Pa.; Chadakoin River at Jamestown, N. Y.; Kiskiminitas River at Salina, Pa.; Blacklick Creek at Blacklick, Pa.

ALLEGHENY RIVER AT REDHOUSE, N. Y.

This station was established September 4, 1903, by R. E. Horton, ssisted by C. C. Covert. It is located at the Redhouse Bridge near he stations of the Erie and Pennsylvania railroads and about 5 miles elow Salamanca, N. Y., and about 13 miles above the point where he river leaves New York State. The standard chain gage is fastened o the upstream side of the bridge near the middle of the left span. he length of the chain from the end of the weight to the marker is 4.16 feet. The gage is read twice each day by James H. Smith. Discharge measurements are made from the downstream side of the ridge. The initial point for soundings is the left end of the downtream side of the bridge. The channel is straight for 800 feet above nd below the bridge. The current velocity is well distributed. The ight bank is high and does not overflow. The left bank overflows nly at flood stages. The bed of the stream is of gravel, and is regular.

The channel is 494 feet wide between abutments, broken by two piers. At extreme high water there is an additional flood channel on the left bank. The bench mark is a circle cut on the downstream side of the left abutment. Its elevation is 21.09 feet above the water surface when the gage reads zero.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Allegheny River at Redhouse, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 10	Horton and Mott	2,807	4.97	8.35	14,220
July 18	C. C. Covert	1,198	.99	3.68	1,188

Mean daily gage height, in feet, of Allegheny River at Redhouse, N. Y., for 1904.

Day.	Jan.[a]	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.[b]	Dec.[b]
1	.....	4.70	6.10	7.30	6.30	7.32	3.25	3.32	3.45	4.50	3.90	3.40
2	.....	4.50	6.85	8.35	5.90	6.55	3.55	3.28	3.38	4.18	3.85	3.40
3	.....	4.35	8.50	7.85	5.55	6.05	3.55	3.20	3.45	4.05	3.80	3.40
4	.....	4.00	8.68	7.28	5.25	5.55	3.40	3.20	3.70	4.00	3.72	3.40
5	.....	4.30	8.00	6.88	4.98	5.32	3.48	3.20	3.45	3.88	3.62	3.90
6	4.50	4.40	7.28	6.55	4.82	5.05	3.82	3.20	3.40	3.78	3.50	3.35
7	4.50	8.60	8.75	6.25	4.60	4.85	3.90	3.20	3.82	3.70	3.50	3.32
8	4.50	10.70	10.50	6.12	4.48	4.60	3.75	3.12	3.30	3.70	3.50	3.30
9	4.50	9.85	10.10	7.80	4.40	4.60	3.60	3.10	3.22	3.80	3.50	3.30
10	4.50	9.00	9.05	8.32	4.25	4.42	6.05	3.00	3.20	4.00	3.50	3.35
11	4.50	8.10	7.82	7.78	4.20	4.25	6.00	3.00	3.20	4.70	3.45	3.52
12	4.50	7.00	6.75	7.50	4.12	4.00	5.20	3.00	3.20	5.00	3.40	3.60
13	4.50	6.00	6.12	7.10	4.05	3.95	5.45	3.00	3.12	5.10	3.50	3.60
14	4.50	5.48	5.50	6.50	3.90	3.80	4.95	3.00	3.10	5.00	3.50	3.55
15	.....	4.90	5.12	6.00	4.05	3.80	4.40	3.00	3.10	4.70	3.45	3.50
16	4.50	4.55	4.85	5.50	4.22	3.75	4.15	3.00	3.10	4.45	3.45	3.50
17	.....	4.40	4.60	5.70	4.15	3.55	3.95	3.00	3.20	4.25	3.40	3.50
18	4.50	4.30	4.68	5.80	4.20	3.50	3.80	3.00	3.25	4.10	3.35	3.50
19	4.50	4.10	4.70	5.65	6.15	3.50	3.70	3.00	3.22	3.95	3.30	3.50
20	4.50	3.95	5.45	5.35	6.20	3.48	3.50	3.15	3.12	3.78	3.30	3.50
21	4.60	.....	5.88	5.20	5.72	3.52	3.48	3.60	3.05	3.68	3.30	3.52
22	7.00	.....	5.55	5.20	5.35	3.62	3.38	4.00	3.00	4.15	3.30	3.60
23	9.95	.....	8.25	5.00	5.15	3.80	3.30	4.35	3.00	5.10	3.30	3.62
24	9.40	4.58	8.85	4.82	5.80	3.65	3.58	4.40	3.05	5.10	3.30	5.25
25	8.95	4.38	8.98	5.22	5.90	3.48	3.45	4.15	4.20	4.90	3.30	5.75
26	8.10	4.00	11.10	5.35	5.65	3.40	3.32	3.90	4.75	4.60	3.25	5.45
27	6.90	3.95	10.70	5.20	6.60	3.28	3.30	3.90	4.70	4.60	3.40	6.05
28	6.45	3.85	9.50	5.80	6.45	3.20	3.30	4.00	4.45	4.50	3.30	8.05
29	6.10	4.10	8.20	6.30	5.78	3.20	3.68	3.70	4.15	4.30	3.20	6.90
30	5.40	.....	7.25	6.70	5.65	3.20	3.65	3.52	4.50	4.20	3.25	6.20
31	5.00	.....	6.88	.....	7.50	.....	3.45	3.45	.....	4.00	.....	5.45

[a] River frozen January 1 to 23. Ice about 1 foot thick.
[b] River frozen November 28 to December 26.

ALLEGHENY RIVER AT KITTANNING, PA.

This station, which is located at Market Street Bridge, was established August 18, 1904, by R. J. Taylor. A standard chain gage is ted to the outside of the upstream hand rail in the first span from left bank. The length of the chain from the end of the weight to marker is 38.67 feet. Discharge measurements are made from downstream foot walk of the five-span steel highway bridge to ich the gage is attached. The initial point for soundings is the t end of the hand rail on the downstream side of the bridge. The annel, which is broken by four piers at the station, is straight for out 500 feet above and for 1,000 feet below. The current is swift. th banks are high, clean, and do not overflow. The bed of the ream is composed of clean gravel, and is permanent. The water is proximately 3 to 4 feet deep in the first three channels and 6 to 8 et deep in the last two at low stages. The gage is read twice daily S. B. Cochrane.

The observations at this station during 1904 have been made under e direction of N. C. Grover, district hydrographer.

Discharge measurements of Allegheny River at Kittanning, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
August 18	R. J. Taylor	620	2,615	0.82	2.40	2,140
September 19	E. C. Murphy	603	2,602	.79	2.26	2,046
September 29	N. C. Grover	720	4,010	1.77	4.42	7,087

Mean daily gage height, in feet, of Allegheny River at Kittanning, Pa., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.[b]	Day.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	.....	2.90	3.80	3.80	2.30	17	.....	2.20	4.00	(a)	2.90
2	.....	2.80	4.00	3.60	2.60	18	.....	2.40	3.70	(a)	3.00
3	.....	2.80	4.00	3.40	2.70	19	.....	2.20	3.50	(a)	3.30
4	.....	2.70	3.80	3.30	2.80	20	.....	2.20	3.30	2.50	3.20
5	.....	2.80	3.80	3.10	2.70	21	.....	2.10	3.20	2.40	3.00
6	.....	3.50	3.40	3.10	2.50	22	.....	2.00	3.30	2.40	2.90
7	.....	3.30	3.40	3.20	2.50	23	.....	2.00	3.30	2.40	2.90
8	.....	3.00	3.10	3.00	2.60	24	.....	2.00	4.30	2.30	3.40
9	.....	2.70	3.00	2.80	2.50	25	4.50	2.00	5.70	2.40	8.30
10	.....	2.70	2.80	2.80	2.30	26	3.90	2.00	6.00	2.40	7.30
11	.....	2.80	2.60	2.80	2.70	27	3.90	3.40	5.70	2.40	8.00
12	.....	2.70	3.40	2.80	2.80	28	4.10	4.60	5.10	2.30	11.90
13	.....	2.60	3.60	2.80	2.80	29	3.70	4.50	4.70	2.30	12.40
14	.....	2.40	4.30	2.70	2.90	30	3.40	4.10	4.40	2.30	10.60
15	.....	2.30	4.40	(a)	2.90	31	3.10	.....	4.10	.....	8.80
16	.....	2.20	4.10	(a)	2.90						

[a] Gage out of order. River stationary from November 15 to 19, inclusive.
[b] Reading taken to top of ice, December 12 to 31.

CHADAKOIN RIVER AT JAMESTOWN, N. Y.

Chadakoin River drains Lake Chautauqua, entering Allegheny River in Pennsylvania, through Conewango Creek. Lake Chautauqua extends in a northwest and southeasterly direction, having its head at a distance of 8 miles from Lake Erie, its water surface being at elevation 1,308 feet above sea level or 735 feet above Lake Erie. The drainage area above the foot of the lake is 190.6 square miles, of which 20.8 square miles comprises the lake surface, which represents 10.9 per cent of the drainage area. The land tributary to the lake is very rolling and the soil is impervious. Chadakoin River furnishes water power at numerous dams.

A gaging station was established on Chadakoin River April 3, 1904, by R. E. Horton. It is located at the outlet of Lake Chautauqua, near Jamestown, N. Y. The gage is read once each day by R. L. Carlson.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Chadakoin River at Jamestown, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 11	Horton and Mott	385	2.88	2.38	1,110
July 19	C. C. Covert	290	1.70	1.90	494

ily gage height, in feet, of Chadakoin River at Jamestown, N. Y., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	.....	2.20	2.40	1.90	1.90	1.50	1.20	2.00	1.70
.....	.....	2.30	2.50	2.00	1.80	1.40	1.50	2.00	1.70
.....	3.00	2.30	2.80	1.90	1.70	1.50	.80	2.00	1.80
.....	2.95	2.20	2.40	2.00	1.60	1.50	.70	2.00	1.70
.....	3.00	2.30	2.60	1.90	2.20	1.50	.80	1.80	1.70
.....	2.95	2.20	2.60	2.00	2.00	1.40	.80	2.00	1.90
.....	2.85	2.10	2.40	2.00	2.00	1.10	.80	1.60	1.60
.....	2.85	2.10	2.40	2.00	2.10	1.10	.80	1.80	1.60
.....	2.80	2.00	2.30	1.80	1.80	1.10	1.30	2.00	1.60
.....	2.80	2.10	2.20	2.20	1.80	1.20	1.40	1.80	1.50
.....	2.80	2.10	2.30	2.40	1.80	1.10	1.40	1.80	1.80
.....	2.70	2.00	2.10	2.30	1.70	1.10	1.50	1.80	1.80
.....	2.80	1.90	2.00	2.30	1.80	.90	1.50	1.90	1.50
.....	2.65	1.90	2.10	2.30	2.10	1.10	1.60	1.90	1.50
.....	2.60	1.80	1.90	2.20	1.70	1.20	1.40	1.80	1.40
.....	2.70	2.10	2.10	2.20	1.70	1.50	1.20	1.80	1.40
.....	2.60	1.90	2.00	2.10	1.90	1.30	1.20	1.80	1.50
.....	2.50	2.00	2.10	2.20	1.70	1.20	1.20	1.70	1.50
.....	2.70	2.10	2.10	1.90	1.40	1.20	1.20	1.70	1.50
.....	2.50	2.20	2.00	1.80	1.90	1.10	1.20	1.80	1.50
.....	2.40	2.20	2.20	2.20	1.80	.90	.....	1.90	1.50
.....	2.40	2.03	2.30	1.80	1.90	.80	.....	1.90	1.40
.....	2.30	2.10	2.20	2.20	1.80	.80	.....	2.00	1.50
.....	2.20	2.30	2.00	1.80	1.80	.80	.....	2.00	1.50
.....	2.30	2.20	2.10	2.00	1.80	1.50	.....	2.00	1.60
.....	2.30	2.30	2.00	2.00	1.70	1.40	1.90	2.00	2.00
.....	2.30	2.50	2.10	2.10	1.50	1.30	1.90	2.00	1.80
.....	2.30	2.40	1.80	2.10	1.90	1.40	1.90	1.80	1.90
.....	2.40	2.20	2.00	2.10	1.70	1.30	1.60	1.80	1.90
.....	2.30	2.10	1.80	1.80	1.60	1.40	2.00	1.70	2.10
.....	.....	2.20	.....	2.00	1.50	.....	2.00	.....	2.00

KISKIMINITAS RIVER AT SALINA, PA.

s station was established August 17, 1904, by R. J. Taylor. It ated at the highway bridge between the village at Salina, Pa., he Pennsylvania Railroad station, and about 200 feet from the . A standard chain gage is bolted to the outside of the hand n the downstream side of the bridge. The length of the chain the end of the weight to the marker is 36.76 feet. Bench mark is a chisel draft on a shelf on the downstream corner of the abutment. Its elevation is 5.77 feet above the datum of the Bench mark No. 2 is a chisel draft on the top of the down- n corner of the right abutment. Its elevation is 30.39 feet the datum of the gage. Discharge measurements are made the downstream side of the two-span steel bridge to which the is attached. The initial point for soundings is the right end of uard rail on the downstream side of the bridge. The channel is

straight for about 300 feet above and for 500 feet below the station. The current is swift. Both banks are high, rocky, clean, and are not subject to overflow. The bed of the stream is composed of rock and is clean and permanent. At low stages all the water passes beneath the right span of the bridge. Water will begin to flow beneath the left span when the gage reads about 1.50 to 1.70 feet. At such time the water in the left channel is too shallow to measure, but the velocity may be estimated very closely. The gage is read once each day by J. F. Whitesell.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Kiskiminitas River at Salina, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second*
August 17	R. J. Taylor	153	222	2.48	1.50	
September 20	F. C. Murphy	144	161	1.74	1.22	
September 30	N. C. Grover	140	132	1.32	1.07	

Mean daily gage height, in feet, of Kiskiminitas River at Salina, Pa., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	D
1		1.15	1.30	1.20	1.90	17		1.40	1.40	1.10	
2		1.15	.90	1.20	.90	18	1.70	1.40	1.22	1.12	
3		1.35	.90	1.35	.90	19	1.65	1.40	1.20	1.10	
4		1.30	.85	1.35	.85	20	1.80	1.30	1.15	1.10	
5		1.20	.90	1.35	.85	21	1.70	1.15	1.10	1.10	
6		1.25	1.00	1.22	1.00	22	1.80	1.15	1.10	1.10	
7		1.15	1.20	1.22	1.10	23	1.78	1.10	1.20	1.05	
8		1.20	1.20	1.00	1.10	24	1.70	1.00	1.55	1.05	b
9		1.25	1.20	1.10	1.10	25	1.62	1.02	1.45	1.02	c
10		1.60	1.20	1.12	1.12	26	1.60	1.02	1.45	1.02	
11		1.60	1.50	1.10	a1.00	27	1.52	1.00	1.30	1.02	
12		1.65	1.52	1.12	1.00	28	1.50	1.00	1.20	1.02	
13		1.50	1.60	1.15	1.00	29	1.38	1.00	1.20	1.00	
14		1.30	1.60	1.20	1.00	30	1.25	1.00	1.15	1.00	d
15		1.35	1.50	1.15	1.00	31	1.20		1.15		d
16		1.40	1.45	1.10	1.00						

a River frozen from December 11 to 24, inclusive.
b December 24 water running over ice.
c Ice gone.
d Ice gorge.

BLACKLICK CREEK AT BLACKLICK, PA.

This station was established August 16, 1904, by R. J. Taylor. is located at the covered wooden highway bridge one-fourth mile fr the railway station at Blacklick. A standard chain gage is spiked the floor on the upstream side of the first span near the left ba

The length of the chain from the end of the weight to the marker is 17.32 feet. The bench mark is a chisel draft on top of upstream corner of left-hand abutment; elevation 15.63 feet above the datum of the gage. During low water discharge measurements are made by wading just below the bridge. At high water discharge measurements are made from a coal-mine tipple crossing the stream one-fourth mile above the bridge to which the gage is attached. The channel is divided at this point by piers into three channels at both low and high water. The gage is read once each day by Mark Maynard.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Blacklick Creek at Blacklick, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
August 12	R. J. Taylor	205	242	0.26	2.02	63
September 20	E. C. Murphy	130	61	.74	1.94	45
September 30	N. C. Grover	100	37	.62	1.84	23

Mean daily gage height, in feet, of Blacklick Creek at Blacklick, Pa., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.88	1.95	2.00	2.05	17	2.18	2.15	2.22	2.15	(a)
2	.....	1.90	1.92	2.00	2.30	18	2.15	2.00	2.20	2.15	(a)
3	.....	1.92	1.85	1.98	2.25	19	2.12	2.00	2.10	2.12	(a)
4	.....	1.90	1.85	1.95	2.25	20	2.02	1.95	2.00	2.00	(a)
5	.....	1.90	1.90	1.90	2.30	21	2.20	1.90	2.25	2.00	(a)
6	.....	1.90	2.10	1.90	2.30	22	2.32	1.90	2.65	1.98	(a)
7	.....	1.90	2.15	2.00	(a)	23	2.42	1.95	2.55	1.95	(a)
8	.....	1.90	2.10	2.10	(a)	24	2.35	1.95	2.45	1.90	(b)
9	.....	2.00	2.00	2.15	(a)	25	2.25	2.00	2.30	2.00	4.20
10	.....	2.10	2.00	2.20	(a)	26	2.50	2.02	2.20	2.00	3.90
11	.....	2.25	2.35	2.25	(a)	27	2.25	2.05	2.20	2.00	6.90
12	.....	2.10	2.62	2.30	(a)	28	2.08	2.02	2.15	2.00	5.30
13	.....	2.02	2.50	2.25	(a)	29	1.98	2.00	2.10	2.00	4.30
14	.....	2.00	2.45	2.20	(a)	30	1.95	2.00	2.10	2.05	3.80
15	.....	2.20	2.30	2.20	(a)	31	1.90	.....	2.00	.....	3.70
16	.....	2.25	2.30	2.15	(a)						

a Ice. b Ice went out.

MONONGAHELA RIVER DRAINAGE BASIN.

Monongahela River is formed near Fairmont in Marion County, in the northern part of West Virginia, by the union of its West Fork with Tygarts Valley River. The headwaters of the latter stream lie on the slopes and in the valleys of the Appalachian Mountains near

the eastern boundary of West Virginia; thence they flow northward, draining a hilly and mountainous country. The West Fork has its headwaters west of those of Tygarts Valley River in the central part of West Virginia; thence they flow northerly, draining a hilly country.

The principal tributaries of Monongahela River below Fairmont are Cheat and Youghiogheny rivers, both entering from the east. Cheat River drains a rugged, mountainous district in northern West Virginia, and flows into Monongahela River near Point Marion, Pa. Youghiogheny River drains a mountainous district of Maryland and Pennsylvania, and enters the Monongahela about 15 miles above Pittsburg. The basins of all of these tributary rivers have steep slopes and collect and discharge their waters quickly, with the result that the Monongahela is liable to the excessive freshets for which it is noted. The whole basin was once heavily timbered, but has been quite thoroughly cleared except about the upper waters of the principal streams. Little water power is used in the basin. Navigation extends to Fairmont.

CHEAT RIVER NEAR MORGANTOWN, W. VA.

A cable station was established July 8, 1899, by E. G. Paul, at Uneva, about 7 miles from Morgantown, W. Va. On July 26, 1901, the cable was moved about 1 mile downstream, in order to secure a more satisfactory cross section and better facilities for observing gage heights. An inclined timber gage was established at the present station August 21, 1902. It is located 275 feet below the cable and is inclined up to 6.5 feet, above which point readings are taken on a vertical timber spiked to an ash tree. On September 28, 1904, a standard chain gage was installed by N. C. Grover on the new steel bridge, known as Ice's ferry bridge, and near the site of the first cable, and both gages have been read during the remainder of the year. They were set to read the same, and their records have checked very closely. The published record is that for the inclined gage. The channel is straight for about 800 feet above and 1,200 feet below the station. The right bank is low and liable to overflow; the left bank is high. The bed of the stream is of rocks and gravel and the current is sluggish. The bench mark is a mark on the face of a sandstone rock at the edge of the road, 20 feet downstream and 30 feet back from the gage. Its elevation above gage datum is 21.13 feet.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Cheat River near Morgantown, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
.....	J. C. Hoyt and W. E. Hall.	300	1,226	0.63	2.60	773
mber 16 ..	R. J. Taylor	275	887	.15	2.00	136

m daily gage height, in feet, of Cheat River near Morgantown, W. Va., for 1904.

y.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	3.30	3.60	6.40	6.40	6.25	3.40	3.60	2.15	1.80	1.60	2.00	2.00
.....	3.25	3.00	6.80	6.50	5.85	3.45	4.00	2.25	1.85	1.85	2.00	2.05
.....	[a]8.50	3.25	7.20	5.95	4.95	3.50	3.65	2.15	1.85	1.90	1.90	2.20
.....	11.00	3.15	8.30	5.10	5.00	3.90	3.35	2.35	1.85	1.90	1.90	2.10
.....	11.00	3.00	6.40	4.55	4.55	3.85	3.00	2.55	1.85	1.90	1.90	2.10
.....	11.00	3.00	5.50	4.30	4.20	4.80	3.00	2.35	1.80	1.85	1.90	2.60
.....	11.00	4.90	6.10	4.15	3.95	4.30	3.65	2.25	1.75	1.85	1.82	2.50
.....	11.00	8.60	7.40	4.05	3.75	4.10	3.50	2.30	1.75	1.90	1.80	2.50
.....	11.00	6.30	6.60	4.05	3.55	3.85	3.40	2.15	1.75	1.80	1.80	2.50
.....	11.00	5.35	5.70	4.15	3.75	3.70	3.30	2.05	1.75	1.90	1.80	2.40
.....	11.00	4.65	5.15	4.00	3.75	3.50	3.55	2.05	1.75	1.95	1.80	2.35
.....	11.00	4.00	5.05	3.85	3.45	3.30	3.50	2.00	1.75	2.00	1.80	2.20
.....	11.00	3.60	4.90	3.80	3.30	3.10	3.35	2.05	1.75	2.05	1.80	2.15
.....	11.00	3.65	4.55	3.85	3.25	2.90	3.05	2.05	1.85	2.75	1.80	2.05
.....	11.00	3.80	5.15	3.70	3.40	2.85	2.80	2.05	1.85	2.30	1.90	2.15
.....	11.00	3.40	4.95	3.95	3.70	2.85	2.70	1.95	2.10	2.20	1.95	2.15
.....	11.00	2.95	4.40	5.05	3.65	2.75	2.55	1.95	1.95	2.15	1.88	2.10
.....	11.00	3.15	4.35	4.65	3.70	2.90	2.55	1.95	2.00	2.05	1.90	2.20
.....	11.00	3.00	4.45	4.25	7.20	2.95	2.35	2.00	1.90	2.00	1.90	2.20
.....	11.00	3.15	4.45	4.00	6.50	2.70	2.30	1.95	1.85	2.00	1.90	2.20
.....	11.00	3.65	5.10	3.80	6.70	3.25	2.75	2.35	2.20	1.90	2.05	2.15
.....	[a]21.00	5.70	5.65	3.60	6.30	4.30	3.00	2.10	2.10	2.00	2.10	2.10
.....	[b]10.80	5.45	8.20	3.45	6.20	4.75	3.25	2.40	1.90	2.00	2.35	2.00
.....	7.50	6.05	7.80	3.35	4.90	3.45	2.80	2.55	1.85	2.10	2.45	2.60
.....	5.95	5.40	6.30	3.55	4.45	3.30	2.60	2.55	1.80	2.10	2.40	8.20
.....	5.05	4.65	5.85	4.70	4.10	2.95	2.45	2.40	1.75	2.00	2.40	7.20
.....	4.40	4.20	6.00	6.60	4.05	2.85	2.55	2.20	1.75	2.00	2.35	7.20
.....	3.80	3.95	5.30	7.40	4.15	2.85	2.45	2.05	1.70	2.10	2.05	6.80
.....	3.75	5.15	4.65	6.30	3.90	3.05	2.50	1.95	1.60	2.00	2.10	5.40
.....	3.65	.....	4.30	6.05	3.70	3.80	2.35	1.85	1.60	2.00	2.00	4.20
.....	3.60	.....	4.35	.....	3.55	.....	2.20	1.85	.....	2.00	.....	3.85

[a] Ice gorge January 3 to 22.

[b] Ice passed out January 23.

YOUGHIOGHENY RIVER AT FRIENDSVILLE, MD.

Youghiogheny River rises in Garrett County, Md., flows in a northwesterly direction into Pennsylvania, and is tributary to Monongahela River 15 miles above Pittsburg. Its source is on the western slope of the Allegheny Mountains, at an elevation of about 2,900 feet. The average fall of the stream for 19 miles above its mouth is about 2 feet per mile, but above this point it soon increases to an average fall of nearly 5 feet per mile. The river is liable to excessive freshets and the height of floods above low water ranges between 15 and 30 feet. The following heights of the high water of February, 1897, above low-water stage, at various points in Pennsylvania, were furnished by George M. Lehman: Whikett, 13 feet; Jacobs Creek, 10 feet; Smithton, 14 feet; Port Royal, 17 feet; Snyder, 16 feet; West Newton, 20 feet; Suterville, 22 feet; Buena Vista, 26.5 feet; Coulterville, 28.5 feet; Boston, 29 feet; McKeesport, 28.5 feet.

A measurement of the flow of Youghiogheny River was made October 13, 1892, with surface floats, at Ohiopyle, Pa., by Kenneth Allen, in connection with an investigation of a water supply for the works of the H. C. Frick Coke Company. It was during a period of extreme drought, and the discharge was found to be 106 second-feet.

The station at Friendsville, Md., was established by E. G. Paul on August 17, 1898. The standard chain gage is located on the upstream side of the right span of the bridge and is nailed to the guard rail. The length of the chain from the end of the weight to the marker is 20 feet. A United States Geological Survey bench mark consisting of an aluminum tablet disk marked "1501," is set in the foundation corner stone of the southeast corner of Friend's store; elevation 33.17 feet above the datum of the gage. The initial point for soundings is a point 15 feet back from the face of the right abutment on the upstream side of the bridge. Measurements are made from the iron highway bridge connecting the east and the west portions of the village. The channel is straight for several hundred feet above and below the bridge. The bed is rocky and the banks are high and not subject to overflow. The gage is read twice daily by J. H. Cuppet. This station was discontinued December 31, 1904.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurement of Youghioghney River at Friendsville, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 7	J. C. Hoyt and W. E. Hall.	145	344	0.46	4.30	157

lean daily gage height, in feet, of Youghiogheny River at Friendsville, Md., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[a]
.....	4.30	5.40	8.00	5.70	5.40	4.90	4.60	4.00	3.90	3.80	3.80	3.90
.....	4.30	5.10	7.60	5.60	5.30	4.90	4.50	4.00	3.80	3.80	3.80	3.90
.....	4.30	5.00	6.80	5.50	5.30	4.90	4.50	4.00	3.80	3.80	3.80	3.90
.....	4.30	4.80	6.40	5.50	5.30	4.90	4.40	4.00	3.80	3.80	3.80	3.90
.....	4.30	4.60	6.10	5.30	5.20	4.80	4.50	4.10	3.80	3.80	3.80	3.90
.....	4.30	4.50	6.00	5.10	5.10	4.80	4.40	4.00	3.80	3.80	3.80	3.90
.....	4.30	6.30	5.90	5.10	4.90	4.70	4.30	3.90	3.80	3.90	3.80	3.90
.....	4.30	6.00	6.30	5.20	4.80	4.90	4.40	3.90	3.80	3.90	3.80	3.90
.....	4.30	6.50	6.60	5.10	4.80	4.80	4.50	3.90	3.90	3.90	3.80	3.90
.....	4.30	6.30	6.40	5.00	4.70	4.70	4.50	3.90	3.80	3.90	3.80	3.90
.....	4.30	6.20	6.20	5.00	4.60	4.60	4.60	3.80	3.80	3.90	3.80	3.90
.....	4.30	5.90	5.90	4.90	4.60	4.50	4.50	3.80	3.80	3.90	3.80	3.90
.....	4.30	5.90	5.70	4.80	4.60	4.40	4.50	3.80	3.80	3.90	3.80	3.90
.....	4.30	5.90	5.40	4.80	4.50	4.40	4.40	3.80	3.80	3.90	3.80	3.90
.....	4.30	5.90	5.20	4.70	4.50	4.30	4.30	3.70	3.80	3.90	3.80	3.90
.....	4.30	5.90	5.00	4.80	4.40	4.30	4.20	3.70	3.80	3.90	3.80	3.90
.....	5.40	5.90	4.90	4.80	4.50	4.30	4.10	3.70	3.80	3.90	3.80	3.90
.....	5.90	5.90	4.80	4.80	5.30	4.30	4.20	3.70	3.80	3.90	3.80	3.90
.....	6.30	5.90	5.00	4.80	6.70	4.30	4.00	3.70	3.80	3.90	3.80	3.90
.....	7.50	5.90	5.20	4.70	6.80	4.40	4.00	3.70	3.80	3.90	3.80	3.90
.....	8.20	5.90	5.30	4.70	6.70	4.50	4.00	3.80	3.80	3.90	3.80	4.60
.....	8.60	6.40	5.60	4.70	6.50	4.50	4.00	3.80	3.80	3.90	3.90	4.80
.....	9.40	6.20	5.80	4.80	6.10	4.70	4.10	3.80	3.80	3.90	3.90	5.90
.....	6.70	6.00	5.60	4.80	5.80	4.80	4.10	3.90	3.80	3.90	3.90	7.80
.....	6.00	6.30	5.70	4.80	5.50	4.70	4.20	3.90	3.80	3.90	3.90	8.60
.....	5.70	6.80	5.90	5.20	5.20	4.60	4.10	3.90	3.80	3.90	3.80	8.30
.....	5.50	7.40	6.00	5.60	5.20	4.50	4.10	3.80	3.80	3.90	3.80	7.50
.....	5.60	7.60	6.30	5.80	5.00	4.50	4.00	3.80	3.80	3.90	3.90	6.70
.....	5.80	8.20	6.20	5.60	5.00	4.60	4.00	3.80	3.80	3.90	3.90	5.90
.....	5.70	.....	6.10	5.40	5.00	4.70	4.00	3.80	3.80	3.90	3.90	5.40
.....	5.50	.....	5.90	.....	5.00	.....	4.10	3.80	.....	3.90	.....	5.10

[a] Frozen during portions of January, February, and December.

ating table for Youghiogheny River at Friendsville, Md., from January 1, 1902, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.6	12	4.4	230	5.6	1,150	6.8	2,512
3.65	18	4.5	280	5.7	1,260	6.9	2,626
3.7	25	4.6	340	5.8	1,372	7.0	2,740
3.75	35	4.7	400	5.9	1,486	7.2	2,968
3.8	45	4.8	464	6.0	1,600	7.4	3,196
3.85	55	4.9	530	6.1	1,714	7.6	3,424
3.9	65	5.0	600	6.2	1,828	7.8	3,652
3.95	77	5.1	685	6.3	1,942	8.0	3,880
4.0	90	5.2	770	6.4	2,056	8.5	4,450
4.1	120	5.3	862	6.5	2,170	9.0	5,020
4.2	150	5.4	955	6.6	2,284	9.5	5,590
4.3	185	5.5	1,050	6.7	2,398		

The above table is applicable only for open-channel conditions. Curve not well defined.

Estimated monthly discharge of Youghiogheny River at Friendsville, Md., for 1904.

[Drainage area, 295 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	5,476	185	1,159	3.93	4.53
February [a]	4,108	280	1,667	5.64	6.09
March	3,880	464	1,551	5.26	6.06
April	1,372	400	703	2.38	2.66
May	2,512	230	883	2.99	3.45
June	530	185	351	1.19	1.33
July	340	90	185	.627	.723
August	120	25	55.3	.187	.216
September	45	45	45	.153	.171
October	65	45	61.1	.207	.239
November	65	45	49.7	.168	.187
December [a]	4,564	65	802	2.72	3.14
The year	5,476	25	626	2.12	28.80

[a] January, February, and December approximate on account of ice during portions of the months.

YOUGHIOGHENY RIVER NEAR CONFLUENCE, PA.

This station was established September 15, 1904, by E. C. Murphy. It is located at the highway bridge about one-half mile from the railway station at Confluence, Pa. A standard chain gage is fastened to the downstream hand rail of the bridge. The length of the chain from the end of the weight to the marker is 23.23 feet. Bench mark No. 1 is a cross on the head of a rivet in the bedplate at the right abutment on the downstream side. Its elevation is 20.53 feet above the datum of the gage. Bench mark No. 2 is a cross on the lower chord of the bridge under the gage box. Its elevation is 20.28 feet above gage datum. Discharge measurements are made from the upstream side of the two-span steel bridge to which the gage is attached. The initial point for soundings is the center of the bridge pin over the right abutment on the upstream side of the bridge. The channel is straight for about 200 feet above and for 500 feet below the station. The current is swift. The right bank is high and does not overflow. The left bank is low, clean, and overflows during high water. The bed of the stream is rocky. There are two channels at all stages. There is a small cobble-stone dam about 4 to 6 inches high under the bridge. The gage is read once daily by L. L. Mountain.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Youghiogheny River near Confluence, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Sec.-feet.*
ıly 7[a]	Hoyt and Hall	235	379	1.40	.....	530
ɜptember 12	E. C. Murphy	78	64	.55	1.30	35
ɜptember 27	N. C. Grover	190	80	.54	1.37	43

[a] Measured at railroad bridge below junction of Casselman River.

Mean daily gage height, in feet, of Youghiogheny River near Confluence, Pa., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
		1.30	1.35	1.40	17	1.35	1.60	1.40	[b] 1.60
		1.30	1.35	1.40	18	1.35	1.60	1.40	([a])
		1.30	1.35	1.40	19	1.35	1.50	1.40	([a])
		1.25	1.35	1.40	20	1.35	1.45	1.40	([a])
		1.25	1.30	1.40	21	1.40	1.40	1.40	([a])
		1.25	1.30	1.40	22	1.40	1.40	1.40	([a])
		1.25	1.30	1.40	23	1.55	1.40	1.40	([a])
		1.30	1.30	1.40	24	1.55	1.40	1.40	[b] 1.90
		1.35	1.30	1.40	25	1.50	1.40	1.40	[c] 4.80
		1.35	1.35	1.40	26	1.40	1.40	1.40	4.25
		1.40	1.35	([a])	27	1.40	1.40	1.40	4.50
		1.40	1.35	([a])	28	1.35	1.35	1.40	4.90
		1.40	1.35	([a])	29	1.35	1.35	1.40	3.80
		1.70	1.35	([a])	30	1.35	1.35	1.40	3.00
		1.70	1.35	([a])	31		1.35		2.70
	1.35	1.65	1.35	([a])					

[a] Frozen. [b] Hole cut in ice and gage read to surface of water. [c] Ice gone out.

CASSELMAN RIVER AT CONFLUENCE, PA.

This station was established September 15, 1904, by E. C. Murphy. t is located at the highway bridge in Confluence, Pa., about 500 'ards from the railroad station. A standard chain gage is fastened o the upstream hand rail of the bridge. The length of the chain rom the end of the weight to the marker is 21.41 feet. Bench mark No. 1 is a chisel draft marked with paint on the right abutment on he downstream side. Its elevation is 17.88 feet above the datum of he gage. Bench mark No. 2 is a cross on the top of the lower chord f the bridge near the gage. Its elevation is 18.61 feet above the atum of the gage. Discharge measurements are made from the pper side of the two-span steel bridge to which the gage is attached. 'he initial point for soundings is the center of the bridge pin over the ight abutment on the upstream side. The channel is straight for 200 eet above and for 500 feet below the station. The current is swift. he right bank is high, and is not subject to overflow. The left bank

is low and overflows during extreme high water. The bed of the stream is covered with bowlders and there is some vegetation. There are two channels at all stages. The gage is read once each day by L. L. Mountain.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Casselman River at Confluence, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 8	Hoyt and Hall	230	279	0.80	1.65	224
September 12	E. C. Murphy	194	123	.36	1.50	44
September 27	N. C. Grover	220	107	.27	1.49	29

Mean daily gage height, in feet, of Casselman River at Confluence, Pa., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		1.40	1.45	1.55	17	1.55	1.50	1.45	[b]1.60
2		1.40	1.45	1.55	18	1.50	1.50	1.45	([a])
3		1.40	1.45	1.55	19	1.45	1.45	1.45	([a])
4		1.35	1.45	1.55	20	1.45	1.40	1.50	([a])
5		1.35	1.40	1.55	21	1.55	1.50	1.50	([a])
6		1.35	1.40	1.55	22	1.50	1.50	1.50	([a])
7		1.35	1.40	1.55	23	1.45	1.50	1.50	([a])
8		1.40	1.40	1.55	24	1.45	1.50	1.55	[b]1.95
9		1.45	1.40	1.55	25	1.45	1.50	1.55	[c]3.35
10		1.45	1.40	1.55	26	1.50	1.50	1.55	2.70
11		1.50	1.40	([a])	27	1.50	1.45	1.55	2.95
12		1.50	1.40	([a])	28	1.45	1.45	1.55	4.10
13		1.50	1.40	([a])	29	1.45	1.45	1.55	3.00
14		1.60	1.40	([a])	30	1.45	1.45	1.55	2.05
15		1.60	1.40	([a])	31		1.45		2.15
16	1.55	1.55	1.40	([a])					

[a] Ice. [b] Hole cut in ice and gage read to surface of water. [c] Ice gone out

LAUREL HILL CREEK AT CONFLUENCE, PA.

This station was established September 15, 1904, by E. C. Murphy. It is located at the highway bridge near the tannery, about one-fourth of a mile from the railroad station at Confluence, Pa. A standard chain gage is fastened to the downstream hand rail of the bridge. The length of the chain from the end of the weight to the marker is 17.55 feet. Bench mark No. 1 is a cross on the top of a bolt in the bed plate of the bridge at the right abutment. Its elevation is 14.16 feet above the datum of the gage. Bench mark No. 2 is a cross on the lower chord of the bridge under the gage box. Its elevation is 14.74 feet above the gage datum. Discharge measurements are made from the lower side of the single-span steel bridge to which the gage is

ched. The initial point for soundings is the center of the bridge over the left abutment on the left side of the bridge. The chan- is straight for about 25 feet above and for 300 feet below the ion. The current is swift. The right bank is low, clean, and sub- to overflow during high water. The left bank is high and not ject to overflow. The bed of the stream is composed of rough blestones and is permanent. There is one channel at all except shet stages. The gage is read daily by L. L. Mountain.

The observations at this station during 1904 have been made under direction of N. C. Grover, district hydrographer.

Discharge measurements of Laurel Hill Creek at Confluence, Pa., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
y 8	Hoyt and Hall	83	156	0.80	2.14	125
tember 12	E. C. Murphy	80	91	.30	1.78	27
tember 27	N. C. Grover	84	84	.19	1.75	16

Mean daily gage height, in feet, of Laurel Hill Creek at Confluence, Pa., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
		1.65	1.60	1.70	17	1.80	1.70	1.70	1.80
		1.65	1.60	1.70	18	1.70	1.65	1.70	1.85
		1.60	1.60	1.70	19	1.65	1.60	1.70	1.85
		1.60	1.60	1.70	20	1.65	1.60	1.70	1.85
		1.60	1.60	1.70	21	1.70	1.60	1.70	1.85
		1.60	1.60	1.70	22	1.70	1.60	1.70	1.85
		1.60	1.65	1.70	23	1.65	1.60	1.70	1.90
		1.65	1.65	1.70	24	1.65	1.60	1.70	[b] 3.00
		1.65	1.65	1.70	25	1.65	1.70	1.70	3.35
		1.65	1.65	1.70	26	1.65	1.70	1.70	2.70
		1.80	1.65	[a] 1.70	27	1.75	1.65	1.70	3.40
		1.80	1.65	1.75	28	1.75	1.65	1.70	3.60
		1.80	1.65	1.75	29	1.70	1.65	1.70	3.00
		1.75	1.65	1.75	30	1.65	1.60	1.70	2.50
		1.70	1.65	1.80	31		1.60		2.40
	1.80	1.70	1.65	1.80					

[a] River frozen from December 11 to 23. [b] Ice gone out.

MAHONING RIVER DRAINAGE BASIN.

Mahoning River rises in the northwestern part of Columbiana County, Ohio, flows north, then turns southeast, entering Ohio River at Beaver, in Beaver County, Pa. This river flows through a hilly and important territory. There are numerous water-power developments on it, and it forms an important adjunct in the water supply and sewage disposal of numerous towns along its course. Among

them is Youngstown, Ohio, where the United States Geological Survey station is maintained. Its drainage area at Youngstown is 958 square miles.

MAHONING RIVER AT YOUNGSTOWN, OHIO.

This station was established May 23, 1903, by R. Winthrop Pratt, and is located about 2 miles below the center of the city of Youngstown, at the highway bridge near the plant of the Hazelton Steel Company. The vertical gage, consisting of a 1-inch by 6-inch board nailed to stakes driven in the river bed 15 feet from the east abutment, was used up to September 23, 1903, at which time a standard chain gage was installed, having a length of 25.36 feet from the end of the weight to the marker. The gage is read once each day by John McVean. Discharge measurements are made from the single-span highway bridge, to which the gage is attached. The initial point for soundings is the face of the parapet wall of the east abutment on the upstream side. The channel is straight for about 800 feet above and 200 feet below the bridge and is 200 feet wide between abutments. Both banks are high and are subject to overflow only at high water. The section is fairly regular and the bed of the stream is composed of gravel and small bowlders, probably not subject to change.

Bench mark No. 1 is the top of the copper plate on the face of the east abutment near the upstream corner. It is 9.37 feet above gage datum. Bench mark No. 2 is the northwest corner of the bridge seat of the west abutment. It is 17.12 feet above gage datum. Bench mark No. 3 is a cut in the end stone of the second tier from the top of the north wing wall of the west abutment. It is 21.34 feet above gage datum. Bench mark No. 4 is a cut in the top hand rail at a point 35 feet from the east abutment on the upstream side. It is 25.88 feet above gage datum. The elevation of the center of the pulley on which the chain of the gage runs is 23.61 feet above gage datum.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Mahoning River at Youngstown, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
January 27	R. W. Pratt	162	654	2.16	2.50	1,413
March 8	do	192	1,624	4.50	7.80	7,322
April 16	do	152	503	1.38	1.86	694
May 18	do	144	393	.56	1.07	219
July 26	do	150	361	.45	.80	164
August 24	do	155	437	1.04	1.35	455
September 15	do	135	335	.21	.65	66
November 3	do	153	360	.30	.74	108

t daily gage height, in feet, of Mahoning River at Youngstown, Ohio, for 1904.

	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.00	1.30	10.00	13.00	5.40	9.00	0.60	0.96	0.88	0.53	0.71	0.67
.....	1.05	1.20	10.00	12.60	4.10	11.40	.80	.77	.65	.43	.70	.66
.....	.90	1.00	9.80	7.00	3.00	10.10	.80	.81	.62	.35	.72	.64
.....	.85	1.10	9.10	3.10	2.50	4.70	.80	.71	.60	.35	.71	.68
.....	.70	1.20	8.80	2.50	1.90	2.90	1.10	.78	.58	.61	.68	.68
.....	.70	1.30	5.20	2.20	1.60	2.20	1.30	.70	.82	.65	.59	.70
.....	.70	7.20	5.70	2.20	1.40	1.80	2.40	.76	.75	.61	.59	.78
.....	.85	10.10	7.90	2.10	1.30	1.50	2.60	.72	.65	.45	.67	.65
.....	.80	10.00	5.70	2.70	1.30	1.40	2.20	.68	.80	.34	.67	.50
.....	.70	5.50	4.00	3.40	1.20	1.40	1.90	.67	.68	.52	.70	.60
.....	.70	3.50	2.80	2.70	1.10	1.30	1.40	.78	.60	.55	.75	.60
.....	.80	2.20	2.50	2.40	1.10	1.20	1.40	.76	.72	.66	.70	.52
.....	.80	1.90	2.00	2.20	1.00	1.10	1.30	.75	.80	.62	.55	.58
.....	.90	1.50	1.90	2.10	1.00	1.00	1.20	.78	.82	.59	.80	.72
.....	.80	1.30	1.70	1.90	1.10	1.00	1.20	.77	.66	.55	.71	.70
.....	.70	1.30	1.60	1.80	1.00	.90	1.20	.75	.61	.55	.70	.71
.....	.90	1.00	1.50	1.70	1.10	.90	1.10	.71	.62	.65	.70	.60
.....	.80	.90	2.70	1.70	1.20	.70	1.00	.69	.44	.61	.75	.40
.....	.90	.90	4.40	1.60	3.10	.70	.80	.70	.65	.70	.50	.48
.....	1.20	.80	4.70	1.50	4.50	.90	.80	.98	.68	.50	.71	.50
.....	4.30	1.00	4.40	1.40	3.30	1.10	.80	.94	.62	.58	.73	.45
.....	14.15	1.60	3.40	1.30	2.20	1.40	.70	1.00	.52	.80	.71	.50
.....	17.45	1.80	5.40	1.20	1.90	1.40	.70	1.40	.50	.51	.55	.63
.....	15.00	2.40	4.90	1.20	4.50	1.30	.60	1.25	.53	.55	.64	.70
.....	9.70	1.90	3.50	1.50	4.70	1.10	.60	1.17	.46	.55	.62	1.00
.....	4.50	1.50	9.20	2.50	5.50	.80	.70	2.05	.72	.57	.50	1.40
.....	3.60	1.90	10.20	3.70	10.10	.80	.85	2.25	.50	.56	.50	2.48
.....	2.50	.90	8.30	3.90	8.70	.70	.87	1.52	.58	.72	.62	3.20
.....	2.30	1.00	5.40	4.80	4.40	.70	.90	1.15	.45	.81	.64	1.81
.....	2.00	.....	3.50	7.10	2.80	.60	.69	1.02	.41	.60	.65	1.80
.....	1.50	.....	3.50	.....	3.30	.....	.61	.93	.....	.64	.....	1.82

[a] Ice conditions January and February.

table for Mahoning River at Youngstown, Ohio, from May 23, 1903, to December 31, 1904.

t.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
	Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
5	8	1.9	750	3.6	2,010	8.5	9,100
5	52	2.0	810	3.8	2,190	9.0	10,120
7	98	2.1	880	4.0	2,390	9.5	11,170
3	146	2.2	950	4.2	2,610	10.0	12,240
9	195	2.3	1,020	4.4	2,830	10.5	13,400
0	245	2.4	1,090	4.6	3,070	11.0	14,600
1	295	2.5	1,160	4.8	3,310	11.5	15,800
2	345	2.6	1,230	5.0	3,550	12.0	17,000
3	395	2.7	1,300	5.5	4,200	13.0	19,400
4	450	2.8	1,370	6.0	4,870	14.0	21,800
5	510	2.9	1,450	6.5	5,620	15.0	24,200
6	570	3.0	1,530	7.0	6,420		
7	630	3.2	1,690	7.5	7,270		
8	690	3.4	1,850	8.0	8,140		

The foregoing table is applicable only for open-channel conditions. It is b upon 15 discharge measurements made during 1903 and 1904. It is well de between gage heights 0.9 foot and 2 feet. The table has been extended beyond t limits. The curve is very unsatisfactory below 0.9 foot gage height. This is p ably due to the dam below this station; at low stages the water may even fall b the crest of the dam. Above gage height 10.4 feet the rating curve is a tangent difference being 240 per tenth.

Estimated monthly discharge of Mahoning River at Youngstown, Ohio, for 1904.

[Drainage area, 958 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dep inc
March	12,700	510	4,726	4.93	5
April	19,400	345	2,615	2.73	3
May	12,470	245	1,959	2.04	2
June	15,560	52	1,686	1.76	
July	1,230	52	310	.324	
August	985	84	236	.246	
September	185	1	70.2	.073	
October	151	0	47.3	.049	
November	146	8	79.6	.083	
December	1,690	0	228	.238	

MUSKINGUM RIVER DRAINAGE BASIN.

Muskingum River is formed by the junction of Walhonding Tuscarawas rivers in the east-central part of Ohio, flows south, enters Ohio River at Marietta, Ohio. In this drainage basin United States Geological Survey operates a station on Licking R at Pleasant Valley, Ohio.

LICKING RIVER AT PLEASANT VALLEY, OHIO.

tation was established November 14, 1902, by Benjamin H. It is located at the highway bridge, 300 feet north of the rail-tion at Pleasant Valley, Ohio. A standard chain gage is to the bridge. The length of the chain from the end of ht to the marker is 20.93 feet. The gage is read once each . B. Lebold. Low-water measurements are made by wading, h-water measurements from the bridge to which the gage is . The channel is straight for 200 feet above and 500 feet e station. The banks are high and not liable to overflow, in extreme floods. The bed of the stream is composed of nd clay. Bench mark No. 1 is three copper nails driven villow tree about 400 feet to the right of the right end ridge, arranged in a vertical position, and having elevations vely 14.92, 15.92, and 16.92 feet above the datum of the gage. ark No. 2 is a nail driven into the outside guard timber near box and has an elevation of 21.52 feet above the datum of .

rainage area at Pleasant Valley is 696 square miles. Licking ows into the Muskingum at Zanesville, Ohio.

charge measurements of Licking River at Pleasant Valley, Ohio, in 1904.

	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
.....	R. W. Pratt.....	66	249	1.65	2.61	412
.....	.....do	61	204	1.59	2.32	324
.....	.....do	74	53	3.31	1.74	176
.....	.....do	95	77	2.17	1.75	167
.....	.....do	177	176	2.40	2.90	422
.....	.....do	65	61	2.68	1.87	163
r 24 [a]	.....do	53	36	2.00	1.54	72
9 [a]	.....do	71	61	2.75	2.00	168
r 26 [a]	.....do	53	35	2.23	1.56	78

[a] Wading.

Mean daily gage height, in feet, of Licking River at Pleasant Valley, Ohio., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	2.80	3.40	4.90	10.80	4.10	9.00	1.80	2.00	1.80	1.55	2.05	1.50
2	2.70	3.20	4.10	13.50	3.80	5.80	1.80	2.20	1.90	1.55	2.05	1.50
3	2.40	3.00	5.30	7.00	3.50	4.40	1.70	2.10	1.80	1.50	2.10	1.50
4	2.20	2.90	7.70	5.20	3.30	3.50	1.70	2.00	1.80	1.50	2.10	1.50
5	2.30	2.90	4.10	4.30	3.10	3.00	1.70	1.90	1.80	1.50	2.10	1.70
6	2.30	3.00	3.30	4.20	2.90	2.70	1.70	1.90	1.70	1.75	2.10	1.55
7	2.40	4.70	7.10	3.90	2.80	2.50	9.20	1.80	1.70	1.65	1.90	1.55
8	2.40	8.90	6.50	3.70	2.60	2.40	14.80	1.80	1.70	1.60	1.80	1.55
9	2.50	5.40	4.90	3.80	2.50	2.30	6.80	1.80	1.70	1.60	1.60	1.55
10	2.50	4.00	3.80	3.70	2.40	2.20	5.30	1.80	1.60	1.70	1.60	1.60
11	2.50	3.20	3.50	3.50	2.30	2.20	4.30	1.80	1.60	2.55	1.60	.....
12	2.40	2.90	3.30	3.50	2.30	2.10	3.90	1.70	1.60	2.05	1.60	.....
13	2.40	2.80	3.30	3.40	2.20	2.00	4.60	1.70	1.60	1.90	1.60	.....
14	2.30	2.70	3.10	3.30	2.20	2.00	4.00	1.70	1.60	1.80	1.60	.....
15	2.30	2.60	3.70	3.20	2.20	1.90	3.30	1.70	1.60	1.75	1.55	.....
16	2.30	2.60	3.30	3.10	2.20	1.90	3.00	1.70	1.60	1.70	1.55	1.70
17	2.30	2.60	3.40	2.90	2.20	2.00	2.80	1.90	1.60	1.65	1.55	.....
18	2.40	2.50	3.50	2.80	2.20	1.90	2.60	1.80	1.60	1.60	1.55	.....
19	2.40	2.40	4.90	2.60	2.30	1.90	2.50	1.80	1.60	1.60	1.55	.....
20	2.50	2.40	4.00	2.50	2.30	2.00	2.40	1.80	1.60	1.60	1.55	.....
21	2.60	2.30	3.60	2.50	2.30	2.00	2.30	1.80	1.60	1.60	1.55	.....
22	14.25	8.70	3.80	2.50	2.20	2.60	2.30	1.80	1.60	1.60	1.55	.....
23	13.20	6.90	5.30	2.40	2.20	2.30	2.20	1.80	1.60	1.60	1.55	1.75
24	7.80	8.70	5.00	2.40	2.40	2.00	2.20	1.80	1.60	1.60	1.55	2.40
25	4.80	5.40	3.90	2.40	2.30	1.90	2.10	1.70	1.60	1.55	1.55	2.75
26	4.60	3.80	7.50	5.20	2.70	1.80	2.00	2.70	1.60	1.55	1.55	2.60
27	4.50	3.60	12.20	6.10	2.50	1.80	2.00	2.00	1.60	1.60	1.50	5.40
28	4.50	3.60	6.40	5.30	2.30	1.70	2.00	1.80	1.60	1.80	1.50	5.40
29	4.40	3.50	4.80	5.40	2.10	1.90	3.70	1.80	1.55	2.00	1.50	3.70
30	4.00	.....	4.20	4.70	2.20	1.90	2.30	1.80	1.55	2.00	1.50	3.00
31	3.70	.....	6.60	.....	2.60	.....	2.10	1.70	.....	2.00	.....	2.40

[a] Ice conditions January and February. [b] River frozen December 10 to 25.

Rating table for Licking River at Pleasant Valley, Ohio, from November 14, 1902, to July 9, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.2	72	2.5	375	3.8	935	6.5	2,610
1.3	77	2.6	412	3.9	985	7.0	2,960
1.4	86	2.7	450	4.0	1,035	7.5	3,310
1.5	99	2.8	490	4.2	1,140	8.0	3,660
1.6	116	2.9	530	4.4	1,250	9.0	4,360
1.7	136	3.0	570	4.6	1,360	10.0	5,060
1.8	159	3.1	610	4.8	1,480	11.0	5,760
1.9	184	3.2	655	5.0	1,600	12.0	6,460
2.0	211	3.3	700	5.2	1,725	13.0	7,160
2.1	240	3.4	745	5.4	1,855	14.0	7,860
2.2	271	3.5	790	5.6	1,985		
2.3	304	3.6	835	5.8	2,120		
2.4	339	3.7	885	6.0	2,260		

The above table is applicable only for open-channel conditions. It is based upon 9 discharge measurements made during 1902 to 1904, inclusive.

The channel changed during flood July 7 to 9, 1904. After this date use the following table.

ting table for Licking River at Pleasant Valley, Ohio, from July 10 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.4	54	2.2	230	3.0	510	3.8	860
1.5	66	2.3	260	3.1	550	3.9	910
1.6	81	2.4	290	3.2	590	4.0	960
1.7	99	2.5	320	3.3	630	4.2	1,080
1.8	120	2.6	350	3.4	670	4.4	1,200
1.9	143	2.7	390	3.5	710	4.6	1,320
2.0	170	2.8	430	3.6	760	4.8	1,440
2.1	200	2.9	470	3.7	810	5.0	1,560

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1904. It is well defined between gage eights 1.25 feet and 3 feet. The table has been extended beyond these limits. bove gage height 5 feet the rating curve is a tangent, the difference being 70 per nth.

Estimated monthly discharge of Licking River at Pleasant Valley, Ohio, for 1904.

[Drainage area, 696 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
arch	6,600	610	1,618	2.32	2.68
pril	7,510	339	1,361	1.96	2.19
lay	1,085	240	408	.586	.676
une	4,360	136	502	.721	.804
uly	8,440	136	913	1.31	1.51
ugust	390	99	137	.197	.227
eptember	143	74	90.2	.130	.145
ctober	335	66	107	.154	.178
ovember	194	66	102	.147	.164
ecember [a]	2,120	66	277	.398	.459

[a] December estimates assumed same as open channel.

KANAWHA RIVER DRAINAGE BASIN.

Kanawha River, which rises in Watauga, Ashe, and Alleghany coun-es, N. C., flows northwesterly through Virginia and West Virginia, and ›ins Ohio River at Point Pleasant, W. Va. In its upper course it ; known as New River. The headwaters lie in the Appalachian Iountains, among the high ridges which form the divides between

the drainage basin of this river and Yadkin River on the east, and of Holston River on the west. The upper tributaries drain narrow valleys of the mountainous region of North Carolina and their slopes are generally steep and their beds are rough. The main river cuts the Alleghany fronts just below Pearisburg, Va.; thence the river's course is through a narrow valley of West Virginia, over a rough bed with many falls and rapids. The basin is as beautiful and picturesque as any in the eastern part of the United States. The country on its lower courses, through which the Cheasapeake and Ohio Railway passes, is noted for its scenic beauty. Below the junction with the Gauley the river is known as the Kanawha.

The principal tributaries of New River are Little River, which empties near Radford, Va., and the Greenbrier, which rises in the eastern part of West Virginia and joins the New at Hinton, W. Va. The following is a list of the stations maintained during 1904 in this drainage basin by the United States Geological Survey: New River at Fayette, W. Va.; Greenbrier River at Alderson, W. Va.; New River at Radford, Va.

NEW RIVER AT RADFORD, VA.

This station is located at the highway bridge near the Norfolk and Western Railway station, and was established by D. C. Humphreys August 1, 1898. The gage used at first was erected by the United States Weather Bureau. It consists of a vertical board graduated to feet and tenths, and is attached to the iron framework connecting the pair of iron concrete cylinders, which form the first pier from the right bank. On account of the inaccessibility of the Weather Bureau gage, a wire gage was put in February 23, 1900, the datum being the same as that of the old gage. On December 1, 1903, the old wire gage was replaced by a standard chain gage, which was installed by W. C. Sawyer. At this time the gage datum was lowered 3.41 feet. The length of the chain from the end of the weight to the marker is 87 feet. The observer is T. M. Brady, saddler and harness dealer, who reads the gage twice daily. The channel is straight for several hundred feet above and below the station and has a width of 580 feet at ordinary stages, broken by five piers. At high water its width is about 1,200 feet. The bottom is of solid rock and gravel and is smooth and regular. On the left bank there is a steep, rocky bluff. The right bank is low and subject to overflow for about 100 yards, but all the water must pass under the bridge, which is about 85 feet above low water. The discharge measurements are made from the upstream side of the bridge. The initial point for soundings is on the right bank of the river, 50 feet from the first pier.

The bench marks described below are all referred to the datum of the chain gage. Bench mark No. 1 is the bottom of the lowest horizontal brace connecting the two cylinders; elevation, 7.28 feet. Bench

mark No. 2 is the top of the lowest horizontal brace on the west side of the bridge, 2.5 feet south of the northwest post of the bent nearest the river on the right bank; elevation, 22.66 feet. Bench mark No. 3 is the northwest corner of the top of the stone under the seventh post from the right bank; elevation, 18.58 feet.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of New River at Radford, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
June 18	F. H. Brundage	530	1,833	1.87	4.07	3,436
September 16	R. H. Bolster	520	1,411	1.10	3.40	1,553
September 29	do	520	1,330	.88	3.24	1,177
October 18	do	518	1,280	.75	3.14	954

Mean daily gage height, in feet, of New River at Radford, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	3.40	4.20	4.10	4.00	4.80	4.70	3.70	3.30	3.20	3.10	3.20
2	3.70	3.60	4.30	4.00	3.80	6.50	4.30	4.00	3.70	3.10	3.10	3.20
3	3.60	3.50	4.20	4.00	3.70	5.70	4.10	4.30	3.80	3.10	3.20	3.20
4	3.40	3.60	4.20	4.00	3.70	2.90	3.90	4.40	3.80	3.10	3.20	3.40
5	3.40	3.70	4.20	3.90	4.50	2.90	4.00	4.30	3.60	3.10	3.20	3.40
6	3.30	3.70	4.10	3.90	4.40	3.30	4.10	4.60	3.50	3.10	3.30	3.70
7	3.30	4.00	4.00	3.90	4.10	4.10	4.10	4.00	3.30	3.10	3.60	4.10
8	3.40	4.80	7.40	3.80	4.00	4.20	3.90	3.90	3.30	3.10	3.40	3.70
9	3.40	4.80	5.50	3.80	4.00	4.30	3.80	4.10	3.40	3.10	3.30	3.60
10	3.40	4.50	5.00	4.20	5.50	4.00	4.00	4.20	3.30	3.10	3.20	3.50
11	3.40	4.20	4.60	4.10	4.80	3.80	4.30	4.70	3.30	3.10	3.10	3.50
12	3.50	3.50	4.40	4.00	4.40	4.00	4.00	4.60	3.30	3.10	3.10	3.50
13	3.50	3.50	4.40	4.00	4.10	4.20	3.80	4.20	3.30	3.00	3.50	3.40
14	3.50	3.20	4.30	3.90	3.90	4.00	3.60	4.00	3.30	3.00	3.70	3.40
15	3.50	3.50	4.20	4.00	3.90	3.80	3.60	3.90	3.30	3.00	3.60	3.30
16	3.50	3.60	4.00	3.80	4.10	4.30	3.60	3.90	3.30	3.00	3.50	3.20
17	3.40	3.80	3.80	3.70	4.10	4.00	3.50	3.90	3.30	3.00	3.50	3.20
18	3.40	3.80	3.80	3.70	4.20	4.00	3.50	3.80	3.30	3.00	3.40	3.40
19	3.40	3.70	3.30	3.60	6.30	4.00	3.40	3.70	3.30	3.00	3.40	3.20
20	3.50	3.30	3.70	3.60	5.20	4.50	3.40	3.60	3.30	3.00	3.40	3.10
21	3.50	3.50	3.70	3.50	4.90	4.10	3.30	3.60	3.20	3.00	3.30	3.10
22	3.80	4.50	3.70	3.50	4.70	3.90	3.30	3.60	3.20	3.00	3.30	3.10
23	5.40	5.30	3.60	3.50	4.50	3.80	3.50	3.70	3.20	3.00	3.20	3.10
24	4.80	4.90	3.90	3.50	4.30	3.70	3.60	3.60	3.20	3.00	3.20	3.30
25	4.30	4.40	4.90	3.50	3.90	3.60	3.70	3.50	3.20	3.00	3.20	3.50
26	3.80	3.90	4.70	3.50	4.00	3.70	3.80	3.50	3.20	3.10	3.20	3.60
27	3.60	3.90	4.70	3.70	4.00	3.90	3.80	3.50	3.20	3.10	3.20	3.50
28	3.40	3.80	4.60	3.90	3.90	3.70	3.90	3.50	3.20	3.10	3.20	3.60
29	3.20	4.10	4.40	4.00	3.80	5.90	4.00	3.40	3.20	3.10	3.20	3.50
30	2.90	.....	4.20	3.90	3.60	5.40	4.50	3.40	3.20	3.10	3.20	3.40
31	3.10	.....	4.00	.....	3.60	.....	4.10	3.30	.....	3.10	.....	3.30

Rating table for New River at Radford, Va., from January 1 to December 31, 190

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-fe*
3.0	690	4.0	3,220	5.0	6,830	6.0	11,500
3.1	895	4.1	3,540	5.1	7,245	6.2	12,550
3.2	1,105	4.2	3,870	5.2	7,670	6.4	13,610
3.3	1,325	4.3	4,205	5.3	8,110	6.6	14,690
3.4	1,555	4.4	4,550	5.4	8,560	6.8	15,790
3.5	1,800	4.5	4,905	5.5	9,020	7.0	16,910
3.6	2,055	4.6	5,270	5.6	9,490	7.2	18,050
3.7	2,325	4.7	5,645	5.7	9,975	7.4	19,200
3.8	2,610	4.8	6,030	5.8	10,470		
3.9	2,910	4.9	6,425	5.9	10,980		

The above table is applicable only for open-channel conditions. It is based u discharge measurements made during 1898 to 1904, inclusive, special weight h given to 1904 measurements. It is well defined between gage heights 3 feet 4.1 feet.

Estimated monthly discharge of New River at Radford, Va., for 1904.

[Drainage area, 2,725 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dept inch
January	8,560	485	2,114	0.776	0.
February	8,110	1,105	3,150	1.16	1.
March	19,200	1,325	4,525	1.66	1.
April	3,870	1,800	2,689	.987	1.
May	13,080	2,055	4,217	1.55	1.
June	14,150	485	4,071	1.49	1.
July	5,645	1,325	2,802	1.03	1.
August	5,645	1,325	2,941	1.08	1.
September	2,610	1,105	1,418	.520	
October	1,105	690	816	.299	
November	2,325	895	1,340	.492	
December	3,540	895	1,570	.576	
The year	19,200	485	2,638	.968	13.

NEW RIVER AT FAYETTE, W. VA.

This station, established by C. C. Babb and D. C. Humphreys J 29, 1895, is located just below the mouth of Wolf Creek, on the hi way bridge of one span at Fayette, W. Va. The wire gage was loc on the guard rail on the upper side of the bridge, about the middl the span, the scale being graduated to feet and tenths. The gag referred to four bench marks: First, the top of the bottom plat the lower plate girder at the end of the first panel from the right b downstream side, 55.13 feet above the zero of the gage; second,

the lower end of the coping on the main pier, right bank, down-
ı side, 52.08 feet above the zero of the gage; third, the bridge
n the right bank, downstream side, 54.54 feet above the zero of
ge; fourth, the west corner of the abutment stone by the Chesa-
and Ohio Railway station, 58.56 feet above the zero of the
A temporary bench mark, established when the chain gage
stalled, is the top of the bottom plate of the plate girder 0.5 foot
of the gage box. Its elevation is 52.57 feet above gage datum.
hannel is straight above and below the station. The current is
and without obstructions, except for immense bowlders in the
n. The banks are high, rocky, and not subject to overflow.
ed is constant in section. The observer is J. R. Durrett, a clerk
store at Fayette, W. Va. The station was discontinued May 22,
On August 11, 1902, it was reestablished. On November 20,
a standard chain gage was installed by W. C. Sawyer. It occu-
he same position as the old wire gage, which it replaced, and it
ıe same datum. The length of the chain from the end of the
t to the marker is 59 feet. The station was discontinued
nber 31, 1904.

observations at this station during 1904 have been made under
rection of N. C. Grover, district hydrographer.

Mean daily gage height, in feet, of New River at Fayette, W. Va., for 1904.

y.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	1.60	1.20	8.00	4.20	7.20	3.80	8.33	2.59	0.55	-0.08	-0.31	0.05
.....	1.90	1.10	9.50	4.80	6.10	5.00	7.17	1.81	.75	-.12	-.25	.05
.....	1.90	1.60	8.20	5.30	5.20	9.30	4.65	1.60	.75	-.19	-.23	.10
.....	1.90	1.50	7.50	4.80	4.70	9.50	4.04	3.12	1.60	-.27	-.04	.15
.....	1.80	2.00	7.00	4.20	5.00	7.40	3.42	2.70	2.25	-.35	-.04	.25
.....	1.90	2.40	6.10	3.70	4.50	5.90	3.01	3.40	1.75	(a)	-.06	1.00
.....	1.90	2.60	5.90	3.60	5.10	4.90	3.65	2.55	1.50	-.41	.05	1.88
.....	1.60	4.40	10.00	3.40	4.50	4.30	3.10	3.41	1.10	-.50	.68	2.70
.....	1.40	8.00	12.20	3.40	4.00	4.00	3.30	2.30	.55	-.54	.86	2.69
.....	1.00	7.00	9.20	3.40	4.00	4.10	2.86	2.20	.65	-.41	.59	2.03
.....	1.30	5.00	7.30	4.10	4.80	4.20	3.66	2.30	.65	-.45	.31	1.85
.....	1.30	3.70	6.40	3.80	5.20	4.00	3.97	2.40	.40	-.45	.11	1.66
.....	1.40	2.80	(a)	3.70	4.30	3.70	3.33	3.56	.52	-.37	.09	1.36
.....	1.20	2.10	5.70	3.50	3.80	4.40	2.55	3.16	.40	-.27	.24	.77
.....	1.10	2.30	5.30	3.50	3.40	3.40	2.15	2.55	.32	-.37	.32	.73
.....	.90	1.70	5.20	3.60	3.30	(a)	1.60	2.10	.38	-.29	.60	.70
.....	.80	1.60	4.90	3.50	3.40	3.07	1.50	1.95	.40	-.37	1.23	.00
.....	.70	1.60	4.40	3.40	3.80	3.11	1.45	1.56	.35	-.42	.99	1.11
.....	.70	1.70	4.00	3.30	8.30	3.05	1.27	2.35	.35	-.42	.75	.55
.....	1.00	1.70	4.00	3.10	13.30	3.10	1.02	2.00	.25	-.46	.57	.91
.....	1.70	2.30	3.80	3.00	10.10	3.68	.86	2.00	.17	-.14	.44	.95
.....	2.00	5.10	3.70	2.70	(a)	3.50	.81	1.75	.04	-.37	.46	.85
.....	5.30	10.50	5.00	2.50	6.60	3.10	.60	1.55	.00	-.42	.50	.73
.....	9.90	9.20	7.30	2.50	6.10	2.82	1.27	1.55	.00	-.21	.39	.80
.....	7.40	7.80	7.30	2.50	6.80	2.50	1.01	1.45	-.04	-.37	.35	1.12
.....	5.50	6.40	7.60	2.80	6.20	2.05	1.45	1.20	-.05	-.37	.40	1.15
.....	4.00	5.10	6.90	5.30	5.80	1.99	1.72	1.05	-.06	-.37	.25	(a)
.....	2.80	4.80	6.30	10.30	5.40	3.56	1.90	.85	-.15	-.17	.30	3.22
.....	2.20	6.00	5.80	10.30	4.50	6.10	2.17	.75	-.08	-.33	.25	2.98
.....	1.70	.....	5.10	8.60	4.00	6.15	2.30	.65	-.06	-.20	.08	2.72
.....	1.40	.....	4.60	.....	3.90	.....	3.36	.50	.....	-.29	.....	2.37

a Observer absent.

Estimated monthly discharge of New River at Fayette, W. Va., for 1904.

[Drainage area, 6,200 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Dept inc
January	22,800	1,755	4,519	0.729	0
February	24,600	2,190	7,790	1.26	1
March	29,700	6,806	13,340	2.15	2
April	24,000	4,479	8,229	1.33	1
May	33,000	6,021	11,070	1.79	2
June	21,600	3,566	8,321	1.34	1
July	18,090	1,665	5,133	.828	
August	6,530	1,580	3,746	.604	
September	4,022	1,155	1,698	.274	
October	1,192	984	1,070	.173	
November	2,362	1,075	1,484	.239	
December	5,866	1,240	2,646	.427	
The year	33,000	984	5,754	.929	12

NOTE.—The above estimate can only be considered as approximate. It is h upon the 1902 rating table with some modification below 2 feet gage height.

GREENBRIER RIVER AT ALDERSON, W. VA.

Greenbrier River rises on the western slope of the Allegheny Mo tains, in Pocahontas County, W. Va., and flows in a southweste direction, emptying into New River near Hinton, Summers Cour W. Va. It receives many short tributaries from the Allegheny Rar and flows for the most part through a broken, hilly, and mountain country well covered with forests. This station, which is 21 m above Hinton, was established by C. C. Babb and D. C. Humphr August 1, 1895. It is located one-half mile above the mouth Muddy Creek, at the highway bridge in the village of Alderson. wire gage which was originally installed was located in the third pe of the second span, downstream side of the bridge. This gage referred to three bench marks: The first, on the upper end of the c ing of the first pier from the left bank, 21.74 feet above gage dat the second, on the upper end of the bridge seat of the left-bank al ment, 21.61 feet above gage datum; the third, on the stone four tion of the water tank of the Chesapeake and Ohio Railway, 23.48 above gage datum. A temporary bench mark has been established the lower end of the third floor beam, in the second span from the bank. Its elevation is 22.72 feet above gage datum. On Novem

20, 1903, a standard chain gage was installed by W. C. Sawyer. It occupies the same position as the wire gage which it replaced, and its datum is the same. The length of the chain from the end of the weight to the marker is 27.81 feet. A new bench mark, to which this gage is referred, is the top of the water table at the northwest corner of the Merchants' Grocery Company building. Its elevation is 21.71 feet above gage datum. The channel, which is straight for 500 feet above and below the station, is broken at the bridge by three piers. At low stages the water flows in two channels, between which is an island 600 feet long and 75 feet wide. The initial point for soundings is the center of the pin on the downstream side of the bridge, on the left bank. The banks are high and not subject to overflow. The bed is of rock and gravel and fairly constant. The observer is W. J. Hancock, merchant at Alderson, W. Va., who reads the gage once daily.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Greenbrier River at Alderson, W. Va., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per. sec.*	*Feet.*	*Second-ft.*
June 15	F. H. Brundage	390	1.26	2.20	490
August 9	N. C. Grover	256	.57	1.72	146
September 20	R. H. Bolster	251	.45	1.63	114
October 1	do	196	.26	1.44	51
October 20	do	217	.35	1.51	76

Mean daily gage height, in feet, of Greenbrier River at Alderson, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.88	2.35	4.65	3.30	3.90	3.00	2.70	1.75	1.55	1.40	1.60	1.60
2	1.90	2.42	5.60	4.20	3.60	3.60	2.50	1.70	1.60	1.40	1.55	1.60
3	2.27	2.20	4.70	4.10	3.40	4.40	2.35	1.60	1.55	1.40	1.45	1.60
4	2.67	1.98	4.40	3.70	3.60	5.25	2.25	1.60	1.55	1.40	1.50	1.60
5	2.93	2.10	3.45	3.35	3.80	3.75	2.25	1.70	1.55	1.40	1.55	1.65
6	2.60	1.90	3.65	3.10	3.10	3.15	2.25	1.75	1.55	1.40	1.50	1.70
7	2.32	2.20	3.40	3.00	3.00	3.00	2.20	1.80	1.55	1.45	1.40	1.90
8	2.20	5.25	6.10	2.95	2.90	2.85	2.20	1.80	1.55	1.50	1.50	1.95
9	2.22	4.50	5.30	2.95	2.80	2.75	2.20	1.70	1.55	1.60	1.45	1.85
10	2.20	3.60	4.35	3.00	2.75	2.65	2.15	1.70	1.55	1.55	1.40	1.75
11	2.10	3.20	3.70	3.00	2.65	2.60	2.10	1.70	1.55	1.60	1.40	1.70
12	2.03	2.80	3.50	3.00	2.65	2.50	2.20	1.75	1.55	1.50	1.50	1.65
13	2.00	2.65	3.50	2.95	2.55	2.45	2.00	1.65	1.60	1.50	1.50	1.65
14	1.97	2.45	3.30	2.95	2.45	2.35	2.00	1.75	1.60	1.50	1.50	1.70
15	1.90	2.32	3.25	2.90	2.45	2.25	1.95	1.70	1.55	1.45	1.60	1.75
16	2.15	2.50	3.40	2.80	2.50	2.20	1.90	1.65	1.50	1.45	1.60	1.75
17	2.12	2.90	3.10	2.80	2.55	2.25	1.85	1.65	1.50	1.40	1.60	1.60
18	2.08	2.10	3.00	2.75	2.65	2.20	1.80	1.70	1.55	1.50	1.60	1.60
19	1.92	2.00	2.90	2.65	7.80	2.15	1.80	1.70	1.50	1.50	1.60	1.60
20	1.85	2.40	2.90	2.65	5.85	2.15	1.80	1.70	1.65	1.50	1.50	1.70
21	1.90	2.45	2.85	2.60	4.75	2.10	1.80	1.75	1.80	1.50	1.55	1.65
22	2.20	5.10	2.85	2.55	4.45	2.10	1.70	1.80	1.50	1.50	1.60	1.65
23	7.70	5.90	3.75	2.45	3.65	2.25	1.70	1.70	1.50	1.45	1.60	1.50
24	5.40	4.60	5.30	2.40	3.45	2.15	1.75	1.80	1.55	1.40	1.60	1.60
25	4.00	4.45	4.40	2.35	3.45	2.20	1.70	1.80	1.50	1.50	1.60	1.75
26	3.25	3.75	3.85	2.45	3.35	2.10	1.80	1.70	1.50	1.45	1.60	2.40
27	3.03	3.25	3.55	3.45	3.20	2.20	1.80	1.65	1.50	1.40	1.60	3.30
28	3.10	2.95	3.45	5.70	3.05	2.40	1.85	1.60	1.60	1.40	1.60	3.20
29	3.15	3.55	3.20	5.00	2.85	2.50	1.80	1.60	1.50	1.40	1.60	3.10
30	2.90	.....	2.95	4.45	2.75	2.85	1.75	1.55	1.40	1.40	1.55	2.85
31	2.63	.....	2.85	.....	2.80	.....	1.75	1.55	.....	1.40	.....	2.50

Rating table for Greenbrier River at Alderson, W. Va., from January 1, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.4	46	2.6	1,000	3.8	3,440	6.0	9,300
1.5	70	2.7	1,160	3.9	3,680	6.5	10,830
1.6	101	2.8	1,330	4.0	3,920	7.0	12,400
1.7	140	2.9	1,510	4.2	4,400	7.5	14,000
1.8	188	3.0	1,700	4.4	4,890	8.0	15,600
1.9	246	3.1	1,900	4.6	5,390	8.5	17,270
2.0	315	3.2	2,110	4.8	5,900	9.0	19,000
2.1	396	3.3	2,320	5.0	6,420	9.5	20,700
2.2	490	3.4	2,540	5.2	6,960	10.0	22,500
2.3	598	3.5	2,760	5.4	7,530	10.5	24,400
2.4	720	3.6	2,980	5.6	8,110	11.0	26,500
2.5	855	3.7	3,210	5.8	8,700		

eceding table is applicable only for open-channel conditions. It is based upon measurements made during 1897 to 1904, inclusive. It is well defined gage heights 1.4 feet and 2.4 feet, being determined between these limits by 1904 measurements. Above 2.4 feet the table is fairly accurate to 6 feet, termined above 6 feet by three measurements made in 1897. Above 9 feet is the same as the 1902 table.

l monthly discharge of Greenbrier River at Alderson, W. Va., for 1903 and 1904.

[Drainage area, 1,344 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
.....	22,290	577	3,711	2.76	3.18
.....	23,620	1,700	6,567	4.89	5.10
.....	30,700	1,160	6,063	4.51	5.20
.....	9,600	1,900	3,298	2.45	2.73
.....	2,540	315	864	.643	.741
.....	8,400	396	1,702	1.27	1.42
.....	2,386	128	754	.561	.647
.....	788	58	239	.178	.205
er.....	301	79	161	.120	.134
.....	246	101	149	.111	.128
er.....	246	70	150	.112	.125
r	490	101	183	.136	.157
e year	30,700	58	1,987	1.48	19.77
1904.					
.....	14,640	217	1,529	1.14	1.31
.....	9,000	246	2,247	1.67	1.80
.....	9,600	1,420	3,515	2.62	3.02
.....	8,400	659	2,219	1.65	1.84
.....	14,960	788	2,715	2.02	2.33
.....	7,100	396	1,328	.988	1.10
.....	1,160	140	352	.262	.302
.....	188	86	141	.105	.121
er.....	188	46	86.4	.064	.071
.....	101	46	60.5	.045	.052
er.....	101	46	83.4	.062	.069
r	2,320	70	412	.307	.354
e year	14,960	46	1,224	.911	12.37

SCIOTO RIVER DRAINAGE BASIN.

Scioto River rises in the eastern part of Auglaize County, Ohio, flows east for about 40 miles and then almost due south, entering the Ohio at Portsmouth. Below Columbus, where it is joined by the Olentangy, it is one of the largest and most important streams in the State. The United States Geological Survey maintained stations on both Scioto and Olentangy rivers at Columbus for the purpose of studying the water supply and sewage disposal of that city. The river has considerable fall and flows through a hilly basin, forming numerous good locations for water-power developments. Its drainage area at Columbus is 1,051 square miles.

SCIOTO RIVER NEAR COLUMBUS, OHIO.

This station was originally established for the Ohio State board of health by B. F. Flynn, on the Grand View Avenue Bridge, 3 miles northwest of Columbus post-office, and was reestablished on the same bridge by R. W. Pratt, on November 21, 1903. This bridge is a two-span iron highway bridge, 250 feet between abutments. The initial point for soundings is the face of the easterly abutment on the downstream side, and the bridge is marked every 10 feet with double nails. The main channel is straight for about 100 feet above and 200 feet below, and there is a small island 150 feet above, which causes a side channel to enter the main channel at this point. The banks are high and only overflow in extreme floods. At low water the river is sluggish, but can be waded at several points below the bridge, where good measurements can be obtained. The following bench marks have been established:

Bench mark No. 1 is the upper side of the upper angle iron forming the lowest part of the hand rail above a point 1 foot east of the pulley. This point is 34.02 feet above the zero of the gage. Bench mark No. 2 is the extreme northeast corner of the north stone of the parapet wall of the east abutment, the elevation of which is 34.32 feet above the zero of the gage. Bench mark No. 3 is a nail in a telegraph pole 10 feet east of the east abutment at the north side, having an elevation of 34.95 feet above the zero of the gage. The gage established by Mr. Pratt has its zero at the same elevation as the gage which was established by Mr. Flynn. It consists of a regulation chain and weight, with a length of 30.40 feet from the end of the weight to the end of the last copper link, which is used as the marker.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Scioto River near Columbus, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
nary 18[a]	R. W. Pratt	36	39	1.31	[b] 9.70	51
nary 22[c]	do	225	3,344	5.43	23.40	18,120
ruary 29[c]	do	246	2,187	2.66	17.60	5,827
rch 4	do	228	3,373	3.98	20.40	13,400
rch 26	do	233	3,426	5.66	23.40	19,400
ril 4	do	235	2,247	4.31	18.00	9,691
y 14	do	123	278	.76	9.81	210
ne 3	do	180	571	1.62	11.14	927
y 21	do	132	317	.76	9.87	241
gust 6	do	100	207	.24	9.12	50
gust 6[d]	do	84	68	.81	9.12	55
tember 3[d]	do	91	78	.46	9.04	36
tober 22[d]	do	77	75	.47	9.10	35
vember 19[d]	do	15	10.5	1.36	8.89	14.3
cember 16	do	16	13.5	1.33	9.08	18

[a] Wading 600 feet above bridge.
[b] Ice caused gage to read about 0.50 too high.
[c] Ice and débris.
[d] Wading 800 feet above bridge.

Mean daily gage height, in feet, of Scioto River near Columbus, Ohio, for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	9.80	14.10	16.00	21.30	12.05	10.00	9.77	9.55	9.03	9.08	9.15	9.13
	9.80	13.30	16.00	24.30	11.70	10.42	9.95	9.55	9.02	9.01	9.00	9.12
	9.85	11.90	19.00	20.80	11.45	10.75	10.10	9.19	8.97	9.00	8.97	9.13
	9.80	11.95	20.65	17.95	11.25	10.55	10.00	9.16	8.97	9.28	8.97	9.12
	9.70	11.95	17.80	16.10	10.78	10.50	10.05	9.12	9.05	9.48	9.17	9.15
	9.75	12.75	16.15	14.45	10.55	10.37	16.02	9.33	9.00	9.27	9.15	9.20
	9.70	17.95	14.35	13.10	10.40	10.10	16.45	9.10	9.06	9.16	9.32	9.06
	9.75	16.15	13.55	12.65	10.25	9.95	15.05	9.03	9.03	9.27	9.15	9.28
	9.80	14.85	13.10	12.55	10.20	9.80	17.60	9.00	9.08	9.12	9.25	9.13
	9.70	14.35	12.55	12.50	10.10	9.70	15.48	9.10	9.03	9.10	9.13	9.15
	9.70	13.60	12.35	12.30	10.00	9.60	13.85	9.15	9.12	9.10	9.31	9.10
	9.70	12.50	12.15	12.15	9.90	9.52	13.02	9.12	9.04	9.10	9.18	9.14
	9.70	12.40	12.45	12.00	9.80	9.50	12.25	9.08	9.00	9.11	9.17	9.22
	9.65	14.15	12.55	11.80	9.82	9.45	11.70	9.10	8.97	9.08	9.08	9.11
	9.70	14.35	12.20	11.55	9.80	9.45	11.32	9.12	8.96	9.15	8.90	9.20
	9.70	13.30	11.35	11.15	9.78	9.45	11.20	9.15	9.02	9.03	9.05	9.10
	9.70	13.15	11.50	10.83	9.72	9.50	10.45	9.01	9.04	9.05	9.09	9.05
	9.70	12.70	11.70	10.65	9.80	9.47	10.67	8.87	8.98	8.98	9.08	9.00
	9.70	12.40	12.80	10.50	9.80	9.50	10.07	9.01	9.04	9.27	9.10	.....
	9.75	12.50	12.70	10.30	9.85	9.95	9.82	9.15	9.10	9.07	9.10	.....
	15.40	12.35	12.65	10.15	9.87	9.80	9.72	9.10	8.97	9.05	9.16	9.20
	23.35	15.50	12.50	10.10	9.90	9.82	9.61	9.22	8.96	9.00	9.32	9.22
	21.60	15.15	13.70	10.10	9.95	10.25	9.55	8.86	9.00	9.00	9.28	9.30
	17.15	15.40	13.90	9.95	10.00	10.52	9.50	8.87	8.94	9.05	9.02	9.30
	14.80	14.55	23.45	10.05	9.85	10.42	9.47	8.90	8.94	9.00	9.10	9.35
	13.75	13.85	23.45	12.60	9.70	10.15	9.40	9.32	8.92	9.00	8.95	9.45
	13.60	13.65	20.00	12.85	9.80	9.87	9.38	9.20	8.92	9.05	9.00	11.10
	15.35	13.55	17.25	12.60	9.80	9.75	9.31	9.05	8.96	9.00	8.95	10.05
	15.05	15.80	15.10	12.35	9.72	10.00	9.35	9.09	8.94	8.87	9.05	9.85
	14.55	.....	13.60	12.25	9.75	9.82	9.29	9.02	9.07	8.81	9.15	10.65
	14.10	.....	15.35	.....	9.83	.....	9.39	8.97	.....	9.00	.....	10.45

[a] Ice conditions during January and February.

Rating table for Scioto River near Columbus, Ohio, from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
8.8	6	10.1	285	11.8	1,000	16.5	7,000
8.9	16	10.2	310	12.0	1,160	17.0	7,890
9.0	29	10.3	335	12.2	1,340	17.5	8,790
9.1	45	10.4	360	12.4	1,540	18.0	9,690
9.2	64	10.5	385	12.6	1,740	18.5	10,590
9.3	86	10.6	410	12.8	1,940	19.0	11,490
9.4	110	10.7	440	13.0	2,140	20.0	13,290
9.5	135	10.8	470	13.5	2,680	21.0	15,090
9.6	160	10.9	500	14.0	3,230	22.0	16,890
9.7	185	11.0	530	14.5	3,860	23.0	18,690
9.8	210	11.2	620	15.0	4,560	24.0	20,490
9.9	235	11.4	730	15.5	5,330		
10.0	260	11.6	860	16.0	6,150		

The above table is applicable only for open-channel conditions. It is based upon 15 discharge measurements made during 1903 and 1904. It is well defined between gage heights 9 feet and 15 feet. The table has been extended beyond these limits. Above gage height 16.6 feet the rating curve is a tangent, the difference being 180 per tenth. The curve includes measurements made during 1899, 1900, and 1903, but the changes due to measurements of 1904 make it applicable only to the above limits.

Estimated monthly discharge of Scioto River near Columbus, Ohio, for 1904.

[Drainage area, 1,051 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	19,500	700	5,180	4.93	5.68
April	21,030	248	3,205	3.05	3.40
May	1,205	185	331	.315	.363
June	455	122	243	.231	.258
July	8,970	84	1,445	1.38	1.59
August	148	12	50.9	.048	.055
September	49	19	30.3	.029	.032
October	130	7	44.5	.042	.048
November	91	16	48.7	.046	.051
December	570	29	110	.105	.121

OLENTANGY RIVER NEAR COLUMBUS, OHIO.

This station was established October 7, 1903, by R. Winthrop Pratt, n connection with the water supply and sewage disposal investigaions of the city of Columbus. It is located 4 miles north of the Columbus, Ohio, post-office and one-fourth mile west of North High treet at the Doddridge Street Bridge. The boxed chain gage is bolted o the hand rail of the bridge on the upstream side. The observer is A. D. Winegardner. Discharge measurements are made from the two-pan highway bridge and by wading below the bridge. The initial point for soundings is the east face of the west parapet wall. The channel is straight for 300 feet above and 500 feet below the station. The banks overflow only at high stages. The bed of the stream is of sand and clay. The drainage area at the station is 520 square miles.

Bench mark No. 1 is the northwest corner of the top stone of the north wing of the west abutment. Its elevation is 34.99 feet above gage datum. Bench mark No. 2 is a cut in the top of the hand rail over the gage 31 feet from the initial point for soundings. Its elevation is 39.89 feet above the zero of the gage. Bench mark No. 3 is the center pin of the west end of the north truss, the elevation of which is 38.60 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction af E. Johnson, jr., district hydrographer.

Discharge measurements at regular stations on Olentangy River near Columbus, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
January 16 [a]	R. W. Pratt	70	36	1.00	6.40	36
January 22	do	186	2,445	5.73	19.40	14,000
February 5 [a b]	do	78	60	1.55	6.90	93
February 22 [c]	do	120	510	3.09	9.40	1,575
February 25 [c]	do	118	530	2.89	9.35	1,529
March 5	do	151	1,104	3.15	11.50	3,469
March 19	do	144	856	1.81	9.20	1,569
April 23 [a]	do	43	53	2.66	7.10	140
May 28 [a]	do	84	86	2.64	7.22	226
June 4	do	137	570	0.44	7.35	249
July 23 [a]	do	50	50	1.24	6.80	62
August 20 [a]	do	31	12	1.16	6.56	14
September 30 [a]	do	20.5	7.2	0.97	6.52	7
October 28 [a]	do	24	10.9	1.87	6.70	20.4
November 12 [a]	do	19.5	9.2	1.16	6.59	10.7
December 23 [a]	do	28	13.6	1.29	6.66	17.5

[a] Wading at different sections. [b] Ice. [c] At Lane avenue, three-fourths mile below station.

Mean daily gage height, in feet, of Olentangy River near Columbus, Ohio, for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	6.50	6.60	13.40	16.30	8.20	8.20	7.20	6.70	6.50	6.50	6.60	6.60
2	6.50	6.60	11.60	19.60	8.20	7.70	7.10	6.60	6.60	6.50	6.60	6.60
3	6.40	6.50	14.80	12.30	7.80	7.60	7.00	6.60	6.75	6.50	6.55	6.60
4	6.40	6.50	15.80	9.80	7.60	7.40	7.00	6.60	6.70	6.50	6.60	6.60
5	6.40	6.60	12.30	8.70	7.50	7.20	7.00	6.60	6.70	6.55	6.60	6.60
6	6.50	9.00	9.20	8.40	7.30	7.20	7.00	6.60	6.65	6.60	6.60	6.60
7	6.50	11.20	9.30	8.10	7.20	7.00	13.05	6.60	6.60	6.55	6.60	6.60
8	6.50	13.10	9.90	7.90	7.20	6.90	11.70	6.60	6.95	6.50	6.60	6.65
9	6.50	10.40	9.00	7.90	7.10	6.90	12.50	6.60	6.90	6.55	6.60	6.60
10	6.40	9.00	8.30	8.10	7.10	6.90	10.00	6.60	6.80	6.65	6.55	6.60
11	6.40	7.40	8.00	8.00	7.00	6.80	8.50	6.60	6.70	6.70	6.55	6.60
12	6.40	7.50	7.90	7.70	7.00	6.80	8.00	6.60	6.60	6.80	6.60	6.60
13	6.40	7.60	7.70	7.80	7.00	6.80	7.60	6.60	6.60	6.80	6.60	6.60
14	6.40	7.20	7.50	7.70	7.00	6.80	7.50	6.60	6.70	6.60	6.60	6.60
15	6.40	7.40	7.70	7.70	7.00	6.80	7.20	6.60	6.60	6.60	6.60	6.60
16	6.40	7.40	7.50	7.50	7.00	7.00	7.20	6.60	6.60	6.60	6.60	6.60
17	6.40	7.00	7.50	7.30	7.00	7.00	7.10	6.60	6.60	6.70	6.60	6.60
18	6.40	6.90	8.00	7.30	7.20	6.90	7.00	6.60	6.60	6.65	6.60	6.60
19	6.40	6.60	9.40	7.20	7.00	6.80	6.90	6.60	6.60	6.65	6.65	6.60
20	6.40	6.70	8.90	7.20	7.10	8.00	6.90	6.60	6.60	6.70	6.60	6.60
21	9.20	6.70	8.00	7.10	7.10	7.10	6.90	6.55	6.60	6.60	6.60	.....
22	20.40	8.80	8.40	7.10	7.20	7.00	6.80	6.50	6.60	6.65	6.60	.....
23	18.90	9.70	10.20	7.10	7.30	7.00	6.80	6.55	6.60	6.60	6.60	6.65
24	16.20	10.00	10.20	7.10	7.20	7.00	6.70	6.50	6.60	6.60	6.60	6.70
25	14.40	9.20	9.70	7.10	7.10	7.20	6.60	6.50	6.60	6.60	6.60	6.85
26	9.40	8.20	16.80	9.50	7.50	7.20	6.60	6.85	6.50	6.65	6.60	6.80
27	7.40	7.90	15.40	9.80	7.30	7.10	6.70	6.80	6.50	6.60	6.60	8.20
28	7.20	7.90	11.80	9.40	7.30	7.00	6.70	6.55	6.50	6.60	6.60	8.30
29	7.50	10.20	9.20	8.80	7.20	7.50	6.70	6.60	6.50	6.65	6.60	7.80
30	7.00	.....	8.50	8.50	7.20	7.50	6.80	6.60	6.50	6.60	6.60	7.00
31	6.60	.....	11.00	.....	7.60	.....	6.70	6.60	.....	6.60	.....	7.20

[a] Ice conditions January and February.

[b] Frozen December 7 to 31.

Rating table for Olentangy River near Columbus, Ohio, from October 7, 1903, to January 22, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.2	13	6.6	55	7.0	133	7.3	234
6.3	21	6.7	69	7.1	163	7.4	275
6.4	31	6.8	85	7.2	197	7.5	320
6.5	43	6.9	107				

During the flood of January 22, 1904, the channel shifted, changing the curve below gage height 7.5 feet, as shown in succeeding table. Above gage height 7.5 the two tables are alike.

Rating table for Olentangy River near Columbus, Ohio, from January 23 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.5	5	8.0	600	9.5	1,630	12.0	3,950
6.6	20	8.1	660	9.6	1,710	12.5	4,500
6.7	39	8.2	720	9.7	1,790	13.0	5,100
6.8	62	8.3	780	9.8	1,870	13.5	5,700
6.9	89	8.4	840	9.9	1,950	14.0	6,300
7.0	118	8.5	910	10.0	2,030	14.5	6,950
7.1	150	8.6	980	10.2	2,210	15.0	7,600
7.2	185	8.7	1,050	10.4	2,390	15.5	8,300
7.3	225	8.8	1,120	10.6	2,570	16.0	9,000
7.4	270	8.9	1,190	10.8	2,750	16.5	9,700
7.5	3.0	9.0	1,260	11.0	2,940	17.0	10,400
7.6	370	9.1	1,330	11.2	3,140	18.0	11,900
7.7	425	9.2	1,400	11.4	3,340	19.0	13,400
7.8	480	9.3	1,470	11.6	3,540		
7.9	540	9.4	1,550	11.8	3,740		

The above table is applicable only for open-channel conditions. It is based upon 4 discharge measurements made during 1904. It is well defined between gage heights 6.2 feet and 11.5 feet. The table has been extended beyond these limits. Above gage height 17 feet the rating curve is a tangent, the difference being 150 per month.

Estimated monthly discharge of Olentangy River near Columbus, Ohio, for 1904.

[Drainage area, 520 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	10,120	320	2,501.	4.81	5.54
April	14,300	150	1,516.	2.92	3.26
May	720	118	232.	.446	.514
June	720	62	187.	.360	.402
July	5,160	20	634.	1.22	1.41
August	76	5	21.5	.041	.047
September	104	5	27.4	.053	.059
October	62	5	23.3	.045	.052
November	30	12	19.5	.038	.042

LITTLE MIAMI RIVER DRAINAGE BASIN.

Little Miami River rises in the southeastern part of Clark County, flows southwest through Greene and Warren counties, and enters Ohio River just above Cincinnati. The greater part of the drainage area lies to the east, as there is only a narrow piece of country between this and Miami River. The Little Miami is the best power river in the State of Ohio. The United States Geological Survey maintained a station on the Little Miami at Morrow in 1903, where its drainage area is 951 square miles. . In 1904 a gaging station was operated on Mad River near Springfield.

MAD RIVER NEAR SPRINGFIELD, OHIO.

This station was established December 31, 1903, by R. Winthrop Pratt. It is located at a highway bridge 4 miles west of Springfield, Ohio, and about 500 feet below old Red Mill dam. A standard chain gage is spiked to the bridge. The length of the chain from the end of the weight to the marker is 16.05 feet. The gage is read once each day by Charles W. Smith. Discharge measurements are made from the downstream side of the single-span bridge to which the gage is fastened. The bridge has a length between abutments of 128 feet. The channel is practically straight for 1,000 feet above and below the station, there being a slight curve just above. The right bank is high, clean, and seldom overflows. The left bank is rather low and is subject to overflow. The bed of the stream is composed of a mixture of clay and gravel and is fairly permanent. Bench mark No. 1 is on the extreme west corner of the second stepstone on the upstream side of the north side of the bridge. Its elevation is 15.88 feet above the datum of the gage. Bench mark No. 2 is on the top of the bottom of the gage box. Its elevation is 19.67 feet above the datum of the gage. Bench mark No. 3 is a nail in top of lower chord, 87 feet from initial point. Its elevation is 18.69 feet above gage datum.

The drainage area at this station is 290 square miles.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Mad River near Springfield, Ohio, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
ry 30	R. W. Pratt	55	224	1.50	6.40	334
ary 27	do	60	292	1.80	6.60	547
25	do	99	701	3.65	10.20	2,559
9	do	63	337	2.43	6.90	820
5	do	65	239	1.10	5.82	262
0[a]	do	82	80	2.17	5.65	174
t 30[a]	do	97	92	1.50	5.56	138
nber 23[a]	do	96	95	1.34	5.50	127
er 18[a]	do	95	99	1.47	5.59	145
nber 17[a]	do	96	117	1.28	5.64	150
ber 28[a]	do	130	939	.43	6.50	407

[a] Wading 500 feet above bridge.

Mean daily gage height, in feet, of Mad River near Springfield, Ohio, for 1904.

ay.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	6.10	6.30	7.90	13.50	6.30	6.00	6.80	5.80	5.60	5.55	5.60	5.65
.....	6.10	6.40	6.90	11.90	6.30	6.00	6.10	5.70	5.55	5.55	5.60	5.68
.....	6.30	6.30	9.60	8.80	6.20	5.90	5.80	5.60	5.55	5.55	5.60	5.67
.....	6.40	6.30	9.20	7.40	6.20	5.90	5.80	5.60	5.60	5.60	5.60	5.62
.....	6.40	6.30	9.30	7.10	6.10	5.80	5.80	5.60	5.50	5.50	5.60	5.63
.....	6.30	6.70	7.00	7.00	6.00	5.80	6.50	5.50	5.52	5.55	5.65	5.60
.....	6.30	10.90	7.00	6.90	6.00	5.80	6.90	5.50	5.50	5.55	5.60	5.60
.....	6.30	8.90	6.90	6.80	6.00	5.80	6.90	5.50	5.50	5.55	5.60	5.60
.....	6.30	8.00	6.60	6.90	6.10	5.80	7.30	5.50	5.50	5.60	5.60	5.60
.....	6.30	6.50	6.50	6.70	6.00	5.80	6.40	5.50	5.50	5.55	5.60	5.65
.....	6.30	6.70	6.90	6.60	5.90	5.80	6.20	5.50	5.50	5.85	5.70	5.60
.....	6.20	6.50	6.70	6.60	5.90	5.70	6.10	5.50	5.45	5.70	5.65	5.62
.....	6.10	6.40	6.50	6.50	5.90	5.70	6.00	5.50	5.50	5.70	5.60	5.60
.....	5.90	6.30	6.60	6.50	5.90	5.70	5.80	5.50	5.60	5.65	5.60	5.60
.....	6.10	6.10	6.50	6.50	6.10	5.70	5.80	5.50	5.15	5.60	5.60	5.60
.....	6.00	6.30	6.50	6.40	6.00	5.80	5.80	5.50	5.50	5.60	5.60	5.63
.....	5.90	6.20	6.50	6.30	5.90	5.90	5.80	5.50	5.50	5.60	5.60	5.63
.....	6.00	6.20	7.50	6.30	6.00	5.90	5.90	5.40	5.50	5.56	5.60	5.62
.....	6.00	6.10	7.00	6.30	6.00	5.80	5.80	5.50	5.50	5.60	5.65	5.70
.....	6.10	6.10	6.80	6.20	5.90	7.00	5.80	5.70	5.32	5.60	5.60	5.60
.....	12.00	6.20	6.70	6.10	6.30	6.30	5.70	5.70	5.50	5.60	5.60	5.60
.....	14.10	8.70	6.60	6.10	6.10	6.10	5.70	5.60	5.55	5.65	5.60	5.60
.....	11.80	8.00	7.70	6.10	6.10	5.90	5.70	5.60	5.50	5.65	5.60	5.70
.....	8.40	9.50	7.20	6.10	6.00	5.80	5.60	5.50	5.45	5.60	5.65	6.10
.....	7.30	7.30	9.30	6.10	6.00	5.80	5.70	5.50	5.70	5.60	5.63	6.20
.....	6.70	6.70	15.40	7.00	5.90	5.80	5.70	5.80	5.60	5.60	5.67	6.20
.....	6.60	6.50	12.00	6.70	6.10	5.80	5.60	5.70	5.60	5.60	5.65	7.90
.....	6.60	8.20	8.30	6.60	6.00	5.80	5.50	5.50	5.60	5.60	5.65	6.35
.....	6.60	8.50	7.50	6.60	5.90	6.10	5.60	5.50	5.60	5.60	5.65	6.15
.....	6.50	.....	8.90	6.50	5.90	5.90	5.50	5.50	5.50	5.65	5.65	6.15
.....	6.40	.....	11.45	.....	5.90	.....	5.50	5.53	.....	5.60	.....	5.95

[a] Ice conditions January and February.

WABASH RIVER DRAINAGE BASIN.

The drainage basin of the Wabash embraces an area of about 33,000 square miles, distributed as follows: In Ohio, 400 square miles; in Indiana, 24,350 square miles; in Illinois, 8,250 square miles. It drains, therefore, slightly more than two-thirds of Indiana, the area of the State being 35,910 square miles. Of the portion of Indiana, about one-half is embraced in the drainage areas of East and West White rivers. By including these drainage areas with the Wabash, the entire basin has a nearly symmetrical, broadly ovate form. Not including the White River system, the Wabash basin is an unsymmetrical, elongated tract, curving around White River.

The length of the valley occupied by the Wabash is about 450 miles, but the length of the stream is fully 500 miles, for the river in its lower course makes several oxbow curves within the valley. The source of the river is about 1,000 feet above tide, while its mouth at low water is but 311 feet. The average fall, if we estimate the stream to have a length of 500 miles, is therefore about 16.5 inches per mile. The rate of descent is far from uniform, being much more rapid in the upper portion than in the lower. There are also many rapids, separated by pools or sluggish portions of the stream. The elevation of the stream is accurately determined at many points, but in the absence of a careful measurement of the length of the stream the rate of fall is only approximately known. The section above the point where the river enters the old lake outlet, estimated to have a length of 100 miles, has a fall of about 300 feet, or 3 feet per mile. Railway levels and canal surveys at the point where the river joins the old lake outlet show its elevation to be nearly 700 feet above sea level, the altitudes reported varying between 696 and 699 feet.

The following table gives the elevation and fall at various points in this basin:

Table of altitudes and distances along Wabash River.

Location.	Estimated distance.	Altitude.	Fall per mile.
	Miles.	*Feet.*	*Feet.*
Source	0.0	1,000.0	0.00
Huntington	100.0	699.0	36.00
South of Salamonie River	15.0	667.0	25.56
South of Mississinewa River	20.0	633.0	20.40
Logansport	20.0	583.0	30.00
Lafayette	50.0	506.0	18.48
Attica	25.0	487.0	9.12
Covington	20.0	470.0	10.20
Terre Haute	55.0	447.7	4.80
State line	14.6	440.6	5.80
Hutsonville, Ill	29.0	424.6	6.60
Vincennes	46.4	398.8	6.60
Mouth of White River	32.5	376.5	8.30
Grayville, Ill	28.0	365.0	5.00
Mouth of Little Wabash	46.0	323.0	11.00
Mouth of Wabash River	16.0	311.0	9.00

During 1904 the United States Geological Survey maintained stations in this basin at Logansport, Delphi, Indianapolis, Cataract, and Shoals. The following are the drainage areas of the several streams at these points.

Drainage areas in Wabash River basin.

	Sq. miles.
Wabash River at Logansport	3,163
Tippecanoe River near Delphi	1,890
Lower Eel River at Cataract	255
White River (East Branch) at Shoals	4,900
White River (West Branch) at Indianapolis	1,520

WABASH RIVER AT LOGANSPORT, IND.

This station was established April 27, 1903, by George E. Waesche. It is located at the Cicott Street Bridge, about 1 mile from the center of the city of Logansport, 1¾ miles from the Wabash Railroad station, 1½ miles from the Pennsylvania station, four blocks from the street car line, and 1,000 feet below the mouth of Eel River. A standard chain gage is placed on the second span of the bridge, at the third panel from the second pier, and is supported by the bridge pins, and is between the lower chord bars. It is reached through a trap door in the floor planks of the bridge. The distance from the end of the weight to the marker is 20.78 feet. The gage is read once each day by W. R. Allison. Discharge measurements are made from the

upstream side of the bridge to which the gage is attached. initial point for soundings is the inner face of the left abutment. channel is nearly straight for 1,000 feet above and for 1,500 feet be the station. The distance between abutments is 550 feet, and channel is broken by three bridge piers. The right bank is high, is not subject to overflow at the bridge. The left bank is subme only at extreme high water. The bed of the stream consists of s rock covered with small bowlders and is rough and permanent. stream is shallow and the current is never sluggish.

Bench mark No. 1 is the top of the north abutment, under the fo board of the downstream sidewalk. Its elevation above gage da is 18.814 feet. From Pennsylvania Railroal levels its elevation al sea level has been found to be 591 feet. Bench mark No. 2 is the of the third course of masonry from the top of the north abutm Its elevation above the zero of the gage is 15.31 feet.

The observations at this station during 1904 have been made u the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Wabash River at Logansport, Ind., in 1903 and 190

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	I ch
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sc*
April 27	G. E. Waesche		978	2.42	2.50	
June 8	do		2,060	3.49	4.55	
June 16	do					
July 8	do		829	1.64	2.30	
July 16	E. C. Murphy		669	1.08	1.54	
August 15	E. Johnson, jr		576	.72	1.35	
September 30	L. R. Stockman		491	.71	1.30	
November 10	do		610	.74	1.38	
December 28[a]	E. Johnson, jr		1,024	1.25	2.75	
1904.						
January 22[b]	F. W. Hanna	528	6,721	6.95	13.11	4
March 2[c]	do	536	4,210	5.62	8.20	2
March 29[c]	do	536	5,335	6.09	10.50	3
May 3	F. W. Hanna and Johnson.		1,536	2.44	2.98	
June 17	F. W. Hanna	483	810	1.08	1.66	
July 21	do	477	814	1.13	1.76	
August 23	do	478	753	.96	1.50	
September 14	do	446	637	.85	1.48	
October 21	do	426	574	.70	1.30	
November 4	do	420	558	.68	1.27	

[a] Partly frozen. [b] Float measurement. [c] Some floating ice.

Mean daily gage height, in feet, of Wabash River at Logansport, Ind., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[a]
.....	2.53	3.10	9.90	12.22	3.75	2.90	1.80	1.30	1.30	1.35	.....	1.30
.....	2.50	3.00	7.88	13.00	3.25	3.00	1.73	1.30	1.33	1.35	1.22	1.35
.....	2.33	2.30	7.65	13.02	2.95	3.00	1.75	1.35	1.27	1.30	1.25	1.45
.....	2.23	2.50	7.88	11.06	2.75	2.90	1.68	1.33	1.21	1.29	1.27	1.22
.....	2.23	2.50	7.30	7.65	2.58	2.70	1.76	1.30	1.25	1.26	1.23	1.28
.....	2.20	3.00	6.50	5.73	2.50	2.40	1.90	1.35	1.30	1.25	1.25	1.22
.....	2.20	10.20	8.19	4.88	2.40	2.30	3.10	1.29	1.24	1.28	1.27	1.22
.....	2.15	9.65	7.35	4.45	2.30	2.20	5.12	1.29	1.20	1.35	1.27	1.28
.....	2.15	7.90	5.83	4.70	2.30	2.00	4.95	1.32	1.25	1.45	1.22	1.25
.....	2.15	6.35	5.00	4.95	2.35	1.90	4.71	1.25	1.25	1.46	1.30	1.18
.....	2.15	5.60	5.00	4.70	2.25	1.90	4.43	1.25	1.25	1.46	1.30	1.31
.....	2.10	5.10	5.15	4.68	2.13	1.82	4.14	1.24	1.25	1.45	1.30	1.20
.....	2.10	4.20	.....	4.30	2.10	1.78	3.53	1.20	1.26	1.45	1.30	1.40
.....	2.20	3.60	4.20	3.90	.....	1.73	2.99	1.25	1.48	1.40	1.31	.....
.....	2.20	2.70	3.70	3.60	.....	1.70	2.69	1.21	1.41	1.37	1.31	.....
.....	2.15	2.50	3.42	3.33	2.00	1.70	2.50	1.25	1.25	1.35	1.25	.....
.....	2.15	2.30	3.45	3.15	1.95	1.65	2.00	1.25	1.30	1.35	1.31	.....
.....	2.20	2.34	5.40	2.90	2.00	1.73	1.99	1.25	1.41	1.29	1.30	.....
.....	2.25	2.38	6.75	2.90	2.15	1.75	1.85	1.25	1.49	1.28	1.30	.....
.....	2.60	2.10	7.00	2.63	2.40	1.90	1.81	1.50	1.49	1.25	1.33	.....
.....	10.85	2.25	6.20	2.52	2.40	2.56	1.78	1.61	1.51	1.30	1.35	.....
.....	13.19	2.21	8.30	2.48	2.35	3.30	1.65	1.76	1.39	1.30	1.35	.....
.....	12.55	2.35	8.10	2.85	2.43	3.15	1.65	1.50	1.37	1.30	1.30	1.31
.....	10.00	3.50	6.68	2.15	2.40	2.97	1.61	1.45	1.37	1.30	1.28	1.35
.....	7.45	4.80	6.85	2.60	2.40	2.49	1.55	1.40	1.40	1.30	1.31	1.41
.....	6.00	4.50	13.45	7.05	2.75	2.20	1.53	1.29	1.56	1.30	1.30	1.50
.....	4.75	3.70	14.84	7.12	2.70	2.00	1.53	1.30	1.50	1.30	1.30	1.73
.....	4.38	3.88	13.05	5.90	2.53	1.93	1.50	1.27	1.56	1.24	1.34	.....
.....	4.00	9.22	10.32	5.25	2.40	1.87	1.50	1.30	1.46	1.22	1.30	4.12
.....	3.70	.....	7.50	4.50	2.43	1.80	1.41	1.33	1.40	1.22	1.28	3.95
.....	3.50	.....	9.10	.....	2.55	.....	1.39	1.34	.....	.....	.....	3.41

[a] Ice conditions January 1 to March 3 and December 14 to 31.

ting table for Wabash River at Logansport, Ind., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.2	260	2.5	2,540	4.2	7,380	8.0	22,770
1.3	360	2.6	2,770	4.4	8,050	8.5	25,060
1.4	480	2.7	3,010	4.6	8,730	9.0	27,410
1.5	620	2.8	3,260	4.8	9,430	9.5	29,790
1.6	770	2.9	3,510	5.0	10,140	10.0	32,200
1.7	930	3.0	3,770	5.2	10,880	10.5	34,650
1.8	1,100	3.1	4,030	5.4	11,640	11.0	37,130
1.9	1,280	3.2	4,300	5.6	12,420	12.0	42,130
2.0	1,470	3.3	4,580	5.8	13,220	13.0	47,130
2.1	1,670	3.4	4,870	6.0	14,040	14.0	52,130
2.2	1,880	3.6	5,460	6.5	16,170	15.0	57,130
2.3	2,090	3.8	6,080	7.0	18,320		
2.4	2,310	4.0	6,720	7.5	20,520		

The preceding table is applicable only for open-channel conditions. It is based upon 19 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.3 feet and 8.2 feet. The table has been extended beyond these limits. Above gage height 10.7 feet the rating curve is a tangent, the difference being 500 per tenth.

Estimated monthly discharge of Wabash River at Logansport, Ind., for 1904.

[Drainage area, 3,163 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimun.	Mean.	Second-feet per square mile.	Depth in inches.
March 4–31	56,140	4,928	19,900	6.29	6.55
April	47,130	1,775	12,860	4.06	4.53
May	5,925	1,375	2,440	.771	.889
June	4,580	850	6,146	1.94	2.16
July	10,580	468	2,673	.845	.974
August	1,032	260	409	.128	.148
September	710	260	439	.139	.155
October	566	280	392	.124	.143
November	420	280	349	.110	.123

TIPPECANOE RIVER NEAR DELPHI, IND.

This station was established March 14, 1903, by George E. Waesche. The station is located at the highway bridge at Springboro, Ind. The nearest railroad station is Delphi, 5 miles east of Springboro. A standard chain gage is located on the second span from the east bank, one panel length beyond the center of the span. The length of the chain from the end of the weight to the marker is 25.66 feet. The gage is read once each day by Lois Imler. Discharge measurements are made from the downstream side of the bridge, to which the gage is attached. The initial point for soundings is the face of the east abutment. The channel is straight for about 1,600 feet above and about 2,000 feet below the station. Its width at ordinary stages is 350 feet, broken by two piers, and at high water is 510 feet, broken by three piers. Both banks are high and can not overflow to any considerable extent. The bed of the stream is rocky and rough; the current is swift. The bench mark is the head of an anchor bolt in the east abutment; it is the outside anchor of the downstream truss. Its elevation above the zero of the gage is 22.25 feet.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of Tippecanoe River near Delphi, Ind., in 1904.

e.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
23	F. W. Hanna	448	2,404	4.10	8.48	9,863
a	do	466	3,920	2.55	13.00	10,010
3	do	449	2,560	4.78	8.80	12,240
	Hanna and Johnson	343	917	4.04	4.95	3,708
	F. W. Hanna	253	328	2.12	2.98	694
	Hanna and Johnson	238	292	1.83	2.92	534
22	F. W. Hanna	255	370	2.38	3.20	882
er 13	do	241	278	1.62	2.85	451
22	do	249	273	1.77	2.90	484
er 5	do	240	266	1.49	2.86	396

a Ice jam.

n daily gage height, in feet, of Tippecanoe River near Delphi, Ind., for 1904.

	Jan.a	Feb.a	Mar.a	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.a
			14.60	9.55	6.59	4.25	3.49	2.85	2.93	3.10	2.83	2.83
			13.44	9.43	5.07	4.21	3.37	2.82	2.90	3.07	2.82	2.82
			13.21	8.49	4.80	3.87	3.21	2.80	2.87	3.05	2.84	2.80
			12.90	8.34	5.60	3.74	3.09	2.81	2.86	3.00	2.84	2.80
			12.37	8.21	5.12	3.65	3.17	2.81	2.84	2.95	2.85	2.91
	4.10	8.25	12.25	8.03	4.96	3.61	3.22	2.77	2.85	2.91	2.85	2.96
			12.80	7.95	4.72	3.49	3.75	2.75	2.83	2.90	2.84	2.97
	3.80		13.20	8.20	4.57	3.45	4.03	2.73	2.83	2.93	2.80	2.98
			12.47	8.75	4.35	3.49	4.40	2.73	2.84	3.00	2.85	3.00
			7.05	8.15	4.05	3.52	4.37	2.72	2.85	3.07	2.87	3.02
			7.00	7.75	4.00	3.43	4.26	2.71	2.85	3.05	2.86	3.00
			6.95	7.08	3.93	3.18	4.20	2.69	2.84	3.00	2.85	2.99
		7.85	6.90	5.53	3.84	3.17	4.17	2.74	2.81	3.00	2.86	2.98
			7.00	4.98	3.89	3.13	3.98	2.73	3.00	2.98	2.84	
			6.87	5.02	3.91	3.13	3.96	2.72	2.98	2.97	2.87	
	3.85		6.77	5.17	3.89	3.12	3.71	2.71	3.01	3.03	2.89	
			7.00	5.17	3.85	3.54	3.55	2.78	3.05	3.00	2.88	3.04
			7.20	5.14	4.01	3.27	3.47	2.80	3.21	2.97	2.86	
			7.23	5.12	3.99	3.20	3.38	2.81	3.10	2.95	2.86	
	4.75	8.20	7.10	5.09	3.95	3.16	3.30	2.90	3.05	2.92	2.85	
	11.05		7.15	4.98	3.90	3.10	3.21	3.05	3.00	2.90	2.83	
	11.25		7.77	4.91	3.81	3.09	3.00	3.35	2.98	2.98	2.80	
	10.95		8.10	4.67	3.70	3.07	2.95	3.42	2.97	2.95	2.85	3.05
			8.54	4.47	3.64	3.06	2.91	3.40	2.95	2.94		3.09
			8.92	4.01	3.73	3.00	2.90	3.35	2.93	2.97		3.12
			11.20	5.80	3.72	2.96	2.90	3.28	3.10	2.95		
	15.00	8.20	9.41	7.03	3.71	3.00	2.99	3.18	3.15	2.92		
			7.94	6.70	3.70	3.83	2.98	2.98	3.23	2.81		
		15.20	7.02	6.35	3.60	3.71	2.93	3.00	3.20	2.85	2.84	
	7.25		6.76	6.10	3.74	3.79	2.91	2.93	3.16	2.85	2.83	3.05
			8.90		4.20		2.89	2.90		2.84		

a Frozen January 1 to March 9 and December 14 to 31.

Rating table for Tippecanoe River near Delphi, Ind., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.7	280	3.8	1,770	4.9	3,640	7.0	8,110
2.8	390	3.9	1,930	5.0	3,830	7.5	9,220
2.9	510	4.0	2,090	5.2	4,230	8.0	10,370
3.0	630	4.1	2,250	5.4	4,650	8.5	11,520
3.1	760	4.2	2,410	5.6	5,070	9.0	12,670
3.2	890	4.3	2,580	5.8	5,490	9.5	13,820
3.3	1,030	4.4	2,750	6.0	5,910	10.0	14,970
3.4	1,170	4.5	2,920	6.2	6,350	10.5	16,120
3.5	1,320	4.6	3,090	6.4	6,790	11.0	17,270
3.6	1,470	4.7	3,270	6.6	7,230	12.0	19,570
3.7	1,620	4.8	3,450	6.8	7,670	13.0	21,870

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.8 feet and 8.8 feet. The table has been extended beyond these limits. Above gage height 7.4 feet the rating curve is a tangent, the difference being 230 per tenth.

Estimated monthly discharge of Tippecanoe River near Delphi, Ind., for 1904.

[Drainage area, 1,890 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 10 to 31	17,730	7,560	9,633	5.10	4.17
April	13,940	2,090	7,210	3.81	4.25
May	7,230	1,470	2,492	1.32	1.52
June	2,495	582	1,199	.634	.707
July	2,750	498	1,247	.660	.761
August	1,200	269	534	.282	.325
September	932	402	601	.318	.355
October	760	402	585	.310	.357
November	498	390	446	.236	.264
December 1 to 13	656	390	543	.287	.139

WHITE RIVER (WEST BRANCH) AT INDIANAPOLIS, IND.

This station was established May 6, 1904, by E. Johnson, jr., assisted by F. W. Hanna. It is located in the central portion of the city on the bridge of the Cleveland, Cincinnati, Chicago, and St. Louis Railway. A standard chain gage is attached to the downstream side of the bridge, the scale being graduated to feet and tenths on the downstream side of the binding tie. The length of the chain from the end of the weight to the marker, which is the outside of the ring, is 37.10 feet. The gage is read twice each day by J. D. Burk. The chain and weight are kept at the water softening plant of the Kingan Packing Company, located 100 feet downstream from the right abutment of the bridge. Discharge measurements are made from the downstream side of the through Pratt truss bridge of three spans, to which the gage is attached. The initial point for soundings is the downstream inner face of the right abutment. The channel is straight for about 500 feet above and for 1,000 feet below the station. The current is direct, but sluggish in low stages. The right bank is moderately high and seldom overflows. The left bank is high, covered by buildings, and never overflows. All the water passes between the abutments of the bridge. The bed of the stream is composed of gravel and sand, and is fairly permanent. There are three channels at all stages. At low water the current is too sluggish to permit of very accurate measurement. Bench mark No. 1 is the south capstone of the ballast wall of the right abutment. Its elevation is 36.51 feet above the datum of the gage. Bench mark No. 2 is the downstream top edge of the fifth cross girder from the right abutment of the bridge. Its elevation is 36.54 feet above the datum of the gage.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

Discharge measurements of White River (West Branch) at Indianapolis, Ind., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 6	Johnson and Hanna	265	1,423	0.81	8.80	1,147
June 17	F. W. Hanna	256	1,324	.65	8.45	866
July 29	do	222	1,129	.34	7.53	380
August 23	do	233	1,210	.41	7.85	495
September 14	do	223	1,042	.23	7.20	240
October 21 [a]	do	68	150	1.43	7.30	216
November 4 [a]	do	68	131	1.49	7.20	195

[a] Measurement made from boat and cable 1 mile below station.

Mean daily gage height, in feet, of White River (West Branch) at Indianapolis, Ind., in 1904.

Day.	Mar.[a]	Apr.[a]	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	18.85	.....	8.90	8.30	7.50	7.30	7.40	7.20	7.10
2	.....	21.66	.....	9.50	8.45	7.45	7.30	7.10	7.20	7.10
3	.....	20.90	.....	9.20	8.35	7.40	7.30	7.30	7.20	7.10
4	.....	14.71	.....	9.10	8.25	7.40	7.20	7.30	7.20	7.10
5	.....	.....	.....	9.10	8.20	7.40	7.20	7.30	7.20	7.10
6	.....	.....	8.80	8.75	8.20	7.35	7.25	7.25	7.20	7.10
7	.....	.....	8.75	8.60	9.10	7.35	7.30	7.25	7.20	7.10
8	.....	.....	8.70	8.40	9.50	7.35	7.30	7.20	7.20	6.75
9	.....	.....	8.70	8.30	9.45	7.30	7.25	7.20	7.30	6.70
10	.....	.....	8.70	8.30	9.20	7.30	7.20	7.20	7.25	7.10
11	.....	.....	8.60	8.20	8.90	7.40	7.20	7.50	7.20	7.10
12	.....	.....	8.50	8.20	8.70	7.30	7.20	7.50	7.20	7.10
13	.....	.....	8.50	8.10	8.50	7.25	7.20	7.40	7.20	7.10
14	.....	.....	8.40	8.10	8.40	7.20	7.25	7.40	7.10	6.90
15	.....	.....	8.40	8.00	8.20	7.15	7.20	7.80	7.20	6.95
16	.....	.....	8.40	8.10	8.10	7.20	7.20	7.30	7.20	7.30
17	.....	.....	8.40	8.50	8.00	7.20	7.20	7.30	7.20	7.15
18	.....	.....	8.50	8.50	8.00	7.10	7.25	7.30	7.20	7.15
19	.....	.....	8.70	8.70	7.90	7.20	7.30	7.30	7.20	7.10
20	.....	.....	8.90	9.10	7.90	7.50	7.55	7.30	7.20	7.10
21	.....	.....	9.10	9.60	7.85	7.80	7.35	7.30	7.20	7.10
22	.....	.....	9.10	9.60	8.00	8.20	7.30	7.30	7.20	7.10
23	.....	.....	8.80	9.00	8.00	8.00	7.30	7.30	7.20	7.20
24	.....	.....	8.70	8.90	7.85	7.65	7.30	7.30	7.20	7.50
25	.....	.....	8.70	8.55	7.80	7.60	7.40	7.25	7.20	7.60
26	21.42	.....	8.60	8.45	7.70	7.40	7.70	7.25	7.20	7.70
27	24.74	.....	8.70	8.40	7.65	7.35	7.60	7.25	7.20	9.20
28	21.21	.....	8.70	8.30	7.60	7.30	7.60	7.20	7.10	9.70
29	13.79	.....	8.80	8.30	7.55	7.30	7.60	7.10	7.10	8.75
30	12.15	.....	8.80	8.30	7.50	7.25	7.60	7.15	7.10	8.45
31	13.26	.....	8.90	.....	7.50	7.30	.....	7.15	.....	8.50

[a] Readings March 26 to April 4 reduced from readings of Kingan gage.

Rating table for White River (West Branch) at Indianapolis, Ind., from May 6 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
7.0	184	7.6	380	8.2	700	8.8	1,150
7.1	211	7.7	425	8.3	770	8.9	1,240
7.2	240	7.8	475	8.4	840	9.0	1,330
7.3	271	7.9	525	8.5	910		
7.4	304	8.0	580	8.6	990		
7.5	340	8.1	640	8.7	1,070		

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904. It is well defined between gage heights 7.2 feet and 8.8 feet. The table has been extended beyond these limits.

ated monthly discharge of White River (West Branch) at Indianapolis, Ind., for 1904.

[Drainage area, 1,520 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
3-31	1,420	840	1,064	0.700	0.677
	1,870	580	1,045	.688	.768
	1,780	340	759	.499	.575
st	700	211	314	.207	.239
mber	425	240	284	.187	.209
er	340	211	265	.174	.201
nber	271	211	238	.157	.175
nber	1,960	115	391	.257	.296

LOWER EEL RIVER NEAR CATARACT, IND.

is station was established August 6, 1903, by E. Johnson, jr., ted by L. R. Stockman. It is located 6 miles from Cloverdale, , and one-half mile northeast of Cataract, Ind. It is 300 feet above n below which there is a fall of 35 feet. The gage is a 3 by 6 inch timber, securely fastened to the west abutment on the downstream It is marked by brass-headed nails and reads from zero to 10 feet. gage is read once each day by Joe Steiner. Discharge measure- ts are made from the upstream side of the single-span, covered high- bridge, which has a length between abutments of 128 feet. The al point for soundings is the face of the left or west abutment at op of the coping on the upstream side. Distances are marked by nails and painted figures on the guard rail on the upstream side he bridge. The channel is straight for about 500 feet above and feet below the bridge. The current varies from swift to rather gish. Both banks are high and rocky and will not overflow. The of the stream is a smooth rock ledge, nearly level between the ge abutments.

ench mark No. 1 is a wire nail in the root of a small elm tree in a e wall on the north side of the road approaching the bridge on west side of the river about 50 feet from the bridge. Its eleva- above the zero of the gage is 12.60 feet. Bench mark No. 2 is a nail in the root of a large oak tree in the pasture on the west of the river 300 feet from the bridge and 20 feet from the fence ch bounds the south side of the road approaching the bridge. The ation of this bench mark is 27.20 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of E. Johnson, jr., district hydrographer.

One measurement was made on May 4, 1904; gage height, 1.28 feet; discharge, 104 second-feet.

Mean daily gage height, in feet, of Eel (lower) River near Cataract, Ind., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	2.40	3.50	4.80	2.00	1.40	1.40	0.90	1.10	1.40	0.80	[b]
2	1.60	2.40	3.60	4.90	2.10	1.30	1.30	.90	1.20	1.40	.80	[b]
3	1.50	2.40	3.70	4.80	2.10	1.30	1.30	.90	1.20	1.30	.70	[b]
4	1.50	2.40	3.70	4.80	2.20	1.30	1.30	.90	1.10	1.30	.70	[b]
5	1.50	2.40	3.60	4.60	2.20	1.20	1.20	.90	1.10	1.20	.70	[b]
6	1.50	2.60	2.70	3.60	2.20	1.20	1.20	.90	1.00	1.10	.80	[b]
7	1.50	4.00	2.90	3.00	2.20	1.30	1.20	.80	1.00	1.10	.90	[b]
8	1.50	4.00	2.90	2.50	2.10	1.40	1.20	.80	.90	1.10	1.00	[b]
9	1.50	4.00	2.60	2.20	2.10	1.40	1.20	.80	.80	1.20	1.00	[b]
10	1.50	4.00	2.60	2.10	2.10	1.40	1.10	.80	.60	1.20	1.00	[b]
11	1.50	3.90	2.70	2.10	2.20	1.30	1.10	.80	.70	1.30	1.00	[b]
12	1.50	3.70	2.60	2.10	2.30	1.30	1.10	.80	.70	1.20	1.00	[b]
13	1.50	3.40	2.30	2.00	2.30	1.40	1.10	.80	.70	1.10	1.10	[b]
14	1.50	3.20	2.25	2.00	2.20	1.40	1.10	.90	.80	1.00	1.10	[b]
15	1.50	3.20	2.30	2.00	2.20	1.40	1.10	.90	.90	1.00	1.10	[b]
16	1.50	3.10	2.40	2.00	2.20	1.40	1.10	.90	1.00	1.00	1.00	[b]
17	1.60	3.00	2.50	2.10	2.10	1.40	1.05	.90	1.00	1.00	1.00	[b]
18	1.70	2.90	2.60	2.10	2.10	1.40	1.05	.90	1.00	1.10	1.10	[b]
19	1.90	2.90	2.70	2.00	2.10	1.40	1.05	.90	1.10	1.10	1.00	[b]
20	2.50	2.90	2.80	2.00	2.00	1.50	1.10	1.00	1.10	1.10	1.00	[b]
21	2.70	2.90	2.90	2.00	2.00	1.50	1.00	1.00	1.20	1.10	1.00	[b]
22	4.10	2.90	3.00	2.00	2.00	1.50	1.00	1.00	1.10	1.00	1.00	0.50
23	4.10	3.00	3.40	2.00	2.00	1.50	1.00	1.00	1.00	1.00	1.00	.80
24	4.00	3.00	3.50	2.20	2.00	1.50	1.00	1.10	1.00	1.00	1.00	1.30
25	3.90	3.00	4.70	2.20	1.80	1.60	1.00	1.20	1.20	1.10	1.00	1.40
26	3.60	3.00	6.60	2.10	1.80	1.60	.90	1.20	1.40	1.00	1.00	1.70
27	3.40	3.00	6.60	2.10	1.70	1.50	.90	1.20	1.45	1.00	.80	2.00
28	3.00	3.20	6.30	2.10	1.60	1.50	.90	1.10	1.55	1.00	.70	2.30
29	2.70	3.40	5.20	2.10	1.50	1.40	.90	1.10	1.50	.90	.50	2.70
30	2.60	.....	4.00	2.00	1.50	1.40	.90	1.10	1.40	.90	.40	3.00
31	2.40	.....	3.90	.....	1.40	.....	.90	1.00	.....	.90	.....	3.30

[a] Ice conditions January and February. [b] Below gage.

NOTE.—The zero of the gage is 0.96 feet below the crest of the dam; therefore when the gage is below 0.96 all the water flows through a small flume.

WHITE RIVER (EAST BRANCH) AT SHOALS, IND.

This station was established June 25, 1903, by A. C. Lootz. It is ated at the highway bridge, in the village of Shoals, Ind., 400 feet ove the Baltimore and Ohio Southwestern Railroad bridge. There rapids just below this station and also about 5½ miles below. The ge is read once each day by O. H. Greist. A standard chain gage fastened to the railing and metal posts of the downstream side of first span on the left end of the highway bridge. The length of chain from the end of the weight to the marker is 46.41 feet. scharge measurements are made from the 3-span highway bridge to ich the gage is attached. The initial point for soundings is the e of the left abutment. The channel is straight above and below station and the current is swift. The right bank is a high rocky d embankment and never overflows; the left bank is a steep rocky iff and does not overflow. The bed of the stream is rocky, and the annel is divided into three parts by the bridge piers. Bench mark . 1 is the stone cap on the downstream end of the first pier from e left bank. Its elevation is 100 feet above gage datum.

The observations at this station during 1904 have been made under e direction of E. Johnson, jr., district hydrographer.

scharge measurements of White River (East Branch) at Shoals, Ind., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per. sec.*	*Feet.*	*Second-ft.*
ne 22 [a]	A. C. Lootz					2,000
igust 4	L. R. Stockman	344	1,083	3.13	65.07	3,392
ptember 24	do	286	408	1.25	63.40	511
1904.						
nuary 24	F. W. Hanna		4,105	4.61	73.47	19,010
arch 5	do	375	2,321	4.99	68.64	11,590
arch 30	do	427	13,410	6.00	95.20	79,820
ay 5	F. W. Hanna and Johnson.	356	1,124	3.72	65.43	4,180
ıne 16	F. W. Hanna	349	789	2.30	64.53	1,812
uly 28	do	307	515	1.60	63.88	823
ugust 24	do	295	379	1.28	63.32	484
eptember 15	do	295	373	1.06	63.24	397
ctober 20	do	295	371	1.07	63.23	396
ovember 3	do	288	324	.99	63.17	320

[a] Float measurement.

Mean daily gage height, in feet, of White River (East Branch) at Shoals, Ind., for 1904.

Day.	Jan.[a]	Feb.[a]	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.[b]
1	64.60	66.20	67.60	91.00	67.00	64.80	65.30	63.80	63.30	63.50	63.20	63.20
2	64.50	65.50	68.10	88.80	66.50	65.60	65.10	63.70	63.30	63.50	63.20	63.20
3	64.30	65.20	68.20	87.20	65.90	66.00	65.00	63.70	63.30	63.50	63.20	63.20
4	64.20	64.90	68.70	85.60	65.60	66.00	64.80	63.70	63.30	63.40	63.20	63.20
5	64.10	64.80	68.60	84.40	65.40	65.60	64.70	63.70	63.30	63.40	63.20	63.20
6	64.10	68.50	69.10	83.40	65.30	65.40	64.50	63.70	63.20	63.30	63.20	63.20
7	64.10	71.50	72.30	80.20	65.10	65.00	64.40	63.70	63.20	63.30	63.20	63.20
8	64.00	72.80	72.90	73.20	65.00	64.90	64.30	63.70	63.20	63.30	63.20	63.20
9	64.00	74.30	71.50	68.40	64.90	64.70	64.30	63.70	63.20	63.30	63.20	63.20
10	64.00	76.10	70.30	67.70	64.80	64.60	64.30	63.60	63.30	63.30	63.20	63.20
11	64.00	77.00	70.50	67.50	64.70	64.50	64.40	63.60	63.30	63.30	63.20	63.20
12	64.00	76.00	69.80	67.30	64.70	64.40	64.50	63.60	63.30	63.30	63.20	63.20
13	64.00	72.50	69.10	67.00	64.70	64.40	64.50	63.50	63.30	63.30	63.20	63.20
14	64.00	68.50	68.90	66.80	64.60	64.30	64.50	63.50	63.30	63.30	63.20	63.20
15	64.00	66.50	68.70	66.50	64.60	64.40	64.40	63.50	63.30	63.30	63.20	63.00
16	64.00	66.00	68.00	66.20	64.50	64.30	64.50	63.50	63.20	63.30	63.20	63.00
17	64.00	65.90	67.60	66.00	64.50	64.50	64.30	63.50	63.20	63.30	63.20	63.10
18	64.00	65.60	67.50	65.80	66.50	64.60	64.20	63.50	63.40	63.30	63.20	63.10
19	64.10	65.40	67.60	65.60	66.50	64.70	64.20	63.50	63.70	63.30	63.20	63.20
20	64.10	65.20	67.70	65.40	64.50	64.90	64.20	63.50	63.60	63.30	63.20	63.20
21	64.60	65.10	67.70	65.30	64.50	64.90	64.20	63.60	63.50	63.30	63.20	63.20
22	69.40	67.30	68.00	65.20	64.50	64.90	64.20	63.60	63.50	63.20	63.20	63.20
23	78.30	68.30	74.40	65.10	64.60	64.80	64.20	63.60	63.40	63.20	63.20	63.20
24	73.50	69.60	75.20	65.10	64.70	64.80	64.10	63.50	63.40	63.20	63.20	63.30
25	74.20	70.90	78.40	65.20	64.60	64.80	64.10	63.40	63.40	63.20	63.20	63.40
26	74.50	70.60	87.10	66.50	64.60	64.80	64.00	63.40	63.70	63.20	63.20	63.90
27	74.80	69.40	87.70	67.50	64.80	64.80	64.00	63.30	63.80	63.20	63.20	64.50
28	75.00	68.00	92.80	68.60	64.60	65.20	63.90	63.30	63.80	63.20	63.20	65.20
29	72.20	67.30	95.00	68.40	64.60	64.80	63.90	63.30	63.70	63.20	63.20	66.00
30	67.80	.....	94.90	67.80	64.60	65.40	63.80	63.30	63.50	63.20	63.20	66.30
31	66.50	.....	93.40	.....	64.70	.....	63.80	63.30	.....	63.20	.....	66.00

[a] Ice conditions January, February, and March; uncertain. [b] Frozen December 15 to 31.

able for White River (East Branch) at Shoals, Ind., from January 1 to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
215	64.7	2,000	67.4	8,110	76.0	30,030
286	64.8	2,150	67.6	8,610	77.0	32,630
360	64.9	2,310	67.8	9,110	80.0	40,430
440	65.0	2,470	68.0	9,610	83.0	48,230
520	65.1	2,640	68.5	10,860	84.0	50,830
605	65.2	2,820	69.0	12,110	85.0	53,430
695	65.3	3,010	69.5	13,360	87.0	58,630
790	65.4	3,210	70.0	14,610	88.0	61,230
890	65.6	3,640	70.5	15,860	90.0	66,430
990	65.8	4,110	71.0	17,110	91.0	69,030
1,100	66.0	4,610	71.5	18,360	92.0	71,630
1,210	66.2	5,110	72.0	19,630	93.0	74,230
1,330	66.4	5,610	72.5	20,930	94.0	76,830
1,450	66.6	6,110	73.0	22,230	95.0	79,430
1,580	66.8	6,610	73.5	23,530		
1,710	67.0	7,110	74.0	24,830		
1,850	67.2	7,610	75.0	27,430		

ve table is applicable only for open-channel conditions. It is based upon ge measurements made during 1903 and 1904. It is well defined between ts 63.2 feet and 65.4 feet. Above gage height 72 feet the rating curve is a e difference being 260 per tenth. Two flood measurements above 65.4 feet t define the tangent. The table has been extended beyond these limits.

l monthly discharge of White River (East Branch) at Shoals, Ind., for 1904.

[Drainage area, 4,900 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	27,430	1,100	7,320	1.49	1.72
.....	32,630	2,150	11,710	2.39	2.58
.....	79,430	8,360	25,310	5.17	5.96
.....	69,330	2,640	1,822	.372	.415
.....	7,110	1,710	2,709	.553	.638
.....	4,610	1,450	2,375	.485	.541
.....	3,010	890	1,539	.314	.362
.....	890	440	647	.132	.152
.....	890	360	525	.107	.119
.....	605	360	435	.089	.103
.....	360	360	360	.073	.081
a.....	5,360	215	932	.190	.219
year	79,430	215	4,640	.947	12.89

nuary, February, March, and December estimates computed as if open channel.

CUMBERLAND RIVER DRAINAGE BASIN.

Cumberland River rises in the eastern part of Kentucky and flows west till it meets the South Fork, which rises in northern Tennessee and flows northward. After this junction the Cumberland turns toward the southwest into Tennessee, and, after flowing through the north-central part, again enters Kentucky in Trigg County, flows across the State, and enters Ohio River at Smithland, about 15 miles above the mouth of Tennessee River. The gaging station on this river is located at Nashville, Tenn.

CUMBERLAND RIVER AT NASHVILLE, TENN.

The gage, which belongs to the United States Engineer Corps, is at the foot of Broad street. It is in three sections, two of which are upright and one inclined. The lowest section, extending from −0.2 foot to +46 feet, is on the slope of the bank and consists of timbers embedded in the ground, bearing an iron strap, into which the markings are cut. The section extending from gage height 46 to 53 feet is fastened to a small building at the top of the bank, and consists of a timber painted white with black markings. The top section of the gage, extending from 52 feet to 55.3 feet, is on the corner of Temperance Hall, painted on the stones in white with black markings. In addition there is a vertical section reading from −1.2 feet to +2 feet. Discharge measurements are made from the upstream side of Woodlawn Street Bridge, which has four spans having a total length of 656 feet. The floor of the bridge is on a slope, the lower or right bank end being about 100 feet above low water. The initial point for soundings is the end of the iron hand rail on the upstream side of the bridge at the left bank. The channel is nearly straight for 2,000 feet above and for 1,500 feet below the station. The right bank is high, but overflows at high stages. It is occupied by lumber yards and saw-mills. The left bank is high, rocky, and is not subject to overflow. The bed of the stream is composed of rock and is permanent. There is one channel broken by one pier at ordinary and by three piers at high water.

During October, 1904, a lock and dam were completed about 2½ miles below the gage, which at low water raises the water surface at the gage about 5½ feet and causes the low-water velocity to become rather slow for good measurements. The datum of the gage corresponds to elevation 110.3 feet of the city levels. A cross, cut on the upper face of the corner stone in the southeast corner of Temperance Hall, on Broad street, near Front street, is 52 feet above the zero of the gage, and 366.6 feet above mean sea level. The highest observed water was 55.3 feet on January 22, 1882. The lowest occurred on October 15 and 16, 1878, at a gage height of −0.4 foot. The danger line is at 40 feet.

Records have been kept for a number of years by the United States Weather Bureau, from which readings previous to those here published may be obtained.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Cumberland River at Nashville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 18	J. M. Giles	344	4,789	2.87	8.25	13,730
May 19	do	344	5,034	2.79	8.35	14,030
May 20	do	344	5,031	2.59	8.13	13,030
August 19	do	313	2,991	.88	2.26	2,630
August 19	do	313	3,000	.88	2.30	2,648
August 20	do	313	2,924	.83	2.22	2,428
October 22	do	328	4,239	.36	[a] 6.60	1,534

[a] Rise in gage height caused by new dam 2¼ miles below station = 5.6.

Mean daily gage height, in feet, of Cumberland River at Nashville, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.50	8.60	10.10	31.90	9.50	6.90	6.20	2.70	2.30	1.00	6.60	6.80
2	9.40	7.60	9.80	24.10	9.80	8.40	5.40	2.70	2.10	1.10	6.60	6.90
3	9.40	6.90	9.70	19.20	9.80	11.70	4.80	3.00	1.90	1.20	6.70	6.90
4	9.70	6.30	9.40	15.40	10.50	14.00	4.80	2.90	3.20	1.10	6.70	6.90
5	9.40	5.80	9.10	13.20	11.40	15.20	4.90	2.70	2.10	1.00	6.80	7.00
6	10.50	5.40	8.70	11.70	12.40	14.40	4.70	2.70	1.80	1.00	6.70	7.00
7	11.00	5.00	9.80	10.40	11.90	13.10	4.60	2.70	1.70	1.00	6.80	7.40
8	10.40	4.90	14.30	9.60	10.90	14.80	4.00	2.60	1.60	1.00	6.80	7.40
9	9.00	4.90	15.70	8.80	10.70	14.70	4.20	2.50	1.70	1.20	6.90	7.50
10	7.60	4.90	17.80	8.50	10.20	14.00	4.50	2.50	1.60	1.00	6.90	8.30
11	6.70	5.70	21.20	8.40	10.00	11.80	4.80	2.40	1.50	[a] 1.50	6.90	8.10
12	6.10	7.20	22.50	8.60	10.20	10.00	4.60	2.50	1.40	2.80	6.90	8.90
13	6.00	8.00	20.70	8.30	10.00	8.70	4.70	2.60	1.40	3.70	6.90	9.00
14	6.00	7.60	18.30	7.80	10.30	7.50	4.10	2.50	1.40	4.60	6.80	8.70
15	7.20	7.20	16.00	7.40	10.00	6.40	3.90	2.50	1.50	5.30	6.80	8.50
16	7.00	7.00	14.40	7.10	9.10	5.50	3.70	2.40	1.40	6.00	6.80	8.30
17	7.10	6.00	14.60	6.80	8.40	4.90	3.60	2.30	1.30	6.50	6.80	8.30
18	9.00	5.60	14.30	6.80	8.30	4.40	3.30	2.30	1.20	6.60	6.90	8.30
19	9.70	5.30	13.60	6.40	8.30	4.30	3.80	2.20	1.20	6.60	6.90	8.30
20	10.00	5.10	13.00	6.20	8.10	3.60	3.70	2.20	1.70	6.60	6.90	8.10
21	11.40	5.00	12.40	6.10	7.50	4.10	3.50	2.20	1.20	6.60	6.90	8.00
22	14.30	5.10	18.10	6.00	6.90	3.70	3.50	2.20	1.30	6.60	6.90	7.80
23	16.80	5.30	21.40	6.00	6.30	3.40	3.70	2.30	1.20	6.60	6.90	7.70
24	16.60	5.30	26.10	6.00	6.00	3.50	3.30	2.30	1.10	6.60	6.90	7.80
25	18.00	5.60	27.90	6.40	5.70	3.40	3.00	2.80	1.00	6.60	6.90	8.30
26	20.00	6.40	31.30	6.70	5.40	3.30	3.00	4.40	1.00	6.60	6.90	8.90
27	20.50	7.90	37.30	6.90	5.00	3.20	3.00	3.90	1.10	6.60	6.90	11.40
28	18.70	9.60	37.20	7.30	4.60	4.20	3.00	3.30	1.10	6.60	6.80	18.40
29	15.60	10.10	36.90	8.00	4.20	5.50	2.80	2.90	1.10	6.60	6.80	16.70
30	12.60	.....	36.20	8.70	4.20	5.40	2.80	2.60	1.00	6.60	6.80	18.50
31	10.00	.....	33.90	.....	5.00	.....	2.70	2.50	.....	6.50	.....	18.80

[a] Dam at lock 2¼ miles below put into operation, raising water level at gage about 5.6 feet above low-water stage.

TENNESSEE RIVER DRAINAGE BASIN.

Tennessee River is formed by the junction of the French Broad and the Holston about 4 miles above Knoxville, Tenn. It flows southwest, crossing into Alabama about 40 miles below Chattanooga, Tenn., and, after crossing the northern part of Alabama, again enters Tennessee in Harding County. It then flows north, crossing Tennessee and Kentucky, and enters Ohio River at Paducah, about 40 miles above Cairo. Its principal tributary on the north is Clinch River, which enters it near Kingston, Roan County, Tenn. The principal tributaries on the south are Hiwassee and Little Tennessee rivers. Hiwassee rises in the northern part of Georgia and flows into the Tennessee about 30 miles above Chattanooga. Its principal tributaries are the Okoee and the Nottely. Little Tennessee River rises in the northeastern corner of Georgia, flows across the southwestern part of North Carolina, and enters the Tennessee near Loudon, Tenn. Its principal tributary is the Tuckasegee. French Broad River rises in the western part of North Carolina. Its principal tributaries are the Pigeon and the Nolichucky. Holston River rises in the western part of Virginia. Its principal tributary is Watauga River, into which stream Roan Creek enters.

FRENCH BROAD RIVER AT HORSESHOE, N. C.

This station was established October 4, 1904, by B. S. Drane. It is located at the steel highway bridge at Horseshoe, N. C. A plain staff gage, graduated to feet and tenths, is attached vertically to a 1½ by 4 inch oak timber which is driven into the bed of the stream to a firm foundation and nailed to an overhanging birch on the right bank, 25 feet below the bridge. The gage is read once each day by Charles Duncan. Discharge measurements are made from the downstream side of the single-span, five-panel truss bridge mounted on stone abutments. The approach on each side is over an earth embankment. On the left bank a flood channel 81 feet wide is opened through the embankment 140 feet from the end of the bridge. The initial point for soundings is on the downstream hand rail over the inner edge of the capstone of the left abutment. The channel is straight for about 2,000 feet above and 1,500 feet below the station. The current is of fair velocity at all stages except at the lowest when it inclines to be sluggish along the right bank. The right bank is of earth, wooded, and about 15 feet high. The left bank is similar but is cleared. The earth embankments on either side to the higher ground are of such a height that all the water passes beneath the bridge and the overflow channel at all stages. There is but one channel at low and ordinary stages. The bed of the stream is composed of sand and a few rocks. It is smooth and permanent. Bench mark No. 1 is the upper surface

the downstream end of the first floor beam from the left bank, 15 et from the initial point for soundings. Its elevation is 20.48 feet ove the zero of the gage. Bench mark No. 2 is the center of the ad of a wire nail driven into the downstream face of a large birch e on the right bank, about 20 feet above the bridge. Its elevation 12.40 feet above the zero of the gage.

The observations at this station during 1904 have been made under e direction of M. R. Hall, district hydrographer.

Discharge measurements of French Broad River at Horseshoe, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
ly 18	B. S. Drane	82	241	1.64	0.86	396
gust 18	do	82	285	1.86	1.51	529
tober 3	do	81	192	1.50	.51	290
cember 7	do	81	318	1.84	1.91	584

lean daily gage height, in feet, of French Broad River at Horseshoe, N. C., for 1904.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
	0.50	0.35	0.60	12	0.40	0.50	1.00	23	0.30	0.65	0.75
	.50	.35	.55	13	.40	1.50	.90	24	.30	.65	.75
	.50	.45	.65	14	35	2.00	.80	25	.30	.55	.90
	.50	2.45	.75	15	35	1.10	.80	26	.35	.55	1.00
	.50	2.10	.75	16	35	.90	.85	27	.35	.55	1.55
	.50	1.75	4.60	17	30	.80	.85	28	.35	.55	6.00
	.50	1.00	2.20	18	30	.75	.95	29	.35	.50	3.30
	.55	.75	1.50	19	30	.70	.85	30	.35	.50	2.15
	.45	.60	1.30	20	30	.65	.80	31	.35	.....	1.80
	.45	.60	1.10	21	30	.60	.80				
	.40	.55	1.10	22	30	.60	.75				

FRENCH BROAD RIVER AT BINGHAM SCHOOL BRIDGE, NEAR ASHEVILLE, N. C.

This station was established in September, 1895, by C. C. Babb. It located at Bingham School Bridge crossing French Broad River at iverside Park, about 3 miles west of Asheville, N. C. It was mainined as a regular station from 1895 to the close of 1901. It is now aintained as a bench-mark station. Discharge measurements are ade from the upstream side of the three-span bridge. The initial point or soundings is the right end of the iron bridge on the upstream side. The channel is straight for about 700 feet above and below the station. The current is swift. Both banks are high, wooded, and not liable to overflow. The bed of the stream is composed of bowlders, very rough,

and permanent. There is but one channel at all stages, broken by two piers at ordinary stages and four piers at high stages. Since the regular station was discontinued a large waterpower development has been installed about six miles below, and it is possible that the rating of the station has been changed and the flow affected. Bench mark No. 1 is the upper edge of the steel plate riveted to the bridge post, over the second floor beam, from the right bank, on the upstream side of the bridge. Its elevation is 20 feet above gage datum. Bench mark No. 2 is the center of the head of a small nail driven into the limb on the downstream side of a large sycamore tree on the right bank, just above the bridge, along which a platform runs out over the water. Its elevation is 11.71 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of French Broad River at Bingham School Bridge, near Asheville, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 21	B. S. Drane	279	564	2.08	2.72	1,172
May 23	do	279	565	2.01	2.64	1,138
July 20	do	268	414	1.52	2.16	629

FRENCH BROAD RIVER AT SMITH BRIDGE, NEAR ASHEVILLE, N. C.

This station was established May 21, 1904, as a bench-mark station. It is located about 1 mile below the Southern Railway depot at Asheville, N. C., and just down the hill from the terminal of the Patton avenue line of the Asheville Street Railway Company. The Southern Railway bridge is about 1,500 feet below and the Bingham School bridge about a mile below the station. A plain staff gage, graduated to feet and tenths, the property of the United States Weather Bureau, is bolted vertically to the southwest corner of the second stone pier from the left bank. A short section, reading from 0.00 downward, is set just downstream from the main section. Discharge measurements are made from the downstream side of the four-span bridge to which the gage is attached. The initial point for soundings is the left end of the downstream hand rail. The channel is straight for about 1,500 feet above and 800 feet below the station. The current has a good velocity. Both banks are clean, and will not overflow beyond the bridge and its approaches. The bed of the stream is composed of sand and silt, with a few scattered bowlders. There is but one channel at all stages, broken by three piers at ordinary stages and five piers at high-water stages. The operations of a waterpower development about 7 miles below will probably affect the flow at this point.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of French Broad River at Smith Bridge, near Asheville, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 21	B. S. Drane	345	843	1.31	-0.24	1,107
July 20	do	339	668	1.06	- .68	707
August 13	do	350	898	1.92	.09	1,725
October 1	do	328	487	1.04	- .91	506
December 10	do	330	656	1.08	.68	707

FRENCH BROAD RIVER AT OLDTOWN, NEAR NEWPORT, TENN.

This was originally one of the temporary stations established in connection with the general hydrographic study of the southern Appalachian region.

The original gage put in at this station was carried away with the old bridge by flood early in the spring of 1902.

A wire gage was established on the new bridge October 27, 1902, by B. S. Drane. The wire gage was replaced April 29, 1903, by a standard chain gage, with inclosed scale, with its zero 133 feet from initial point for soundings. This gage was made to read the same as the one which it replaced. The length of the chain from the end of the weight to the marker is 28 feet. Discharge measurements are made from the downstream side of the steel highway bridge, in four spans, to which the gage is attached. The initial point for soundings is the end of the guard rail at the left end of the bridge, on the downstream side. The channel is straight for about 600 feet above and below the station. The velocity is moderately swift, well distributed, and can be measured at all stages. Both banks are high and wooded, and all water passes beneath the bridge at all stages. The section is smooth and regular, and the bed is of gravel and sand, not subject to much change.

Bench mark No. 1 is a point marked in white paint on the sharp, rectangular corner of the angle iron connection between the floor beam and the first post on the downstream side in the second span from the left end of the bridge. This point is toward the right bank and is 25.84 feet above gage datum. Bench mark No. 2 is the top of the copper bolt set in a bowlder projecting from the hillside on the left bank 175 feet downstream from the center line of the bridge, 8 feet from the center of the road, and about 4 feet above ground. This rock is the first smooth-faced ledge of limestone outcropping close to the road. The face next the road is nearly vertical for a length of 4 feet. The elevation of the bench mark is 29.52 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer:

Discharge measurements of French Broad River at Oldtown, near Newport, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 23	B. S. Drane	453	2,155	2.59	2.92	5,568
February 23	do	453	2,136	2.51	2.87	5,358
March 29	do	450	1,928	1.97	2.34	3,804
April 27	M. R. Hall	448	1,925	1.57	2.12	3,025
July 8	J. M. Giles	334	1,371	.76	1.30	1,045
August 20	B. S. Drane	463	1,492	.92	1.50	1,380
October 15	do	442	1,267	.40	.98	508

Mean daily gage height, in feet, of French Broad River at Oldtown, near Newport, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.50	1.90	2.00	2.00	2.30	1.95	1.40	1.45	1.10	0.95	1.25
2	1.30	1.50	2.00	1.90	1.80	2.40	1.70	1.70	1.40	1.10	1.00	1.20
3	1.30	1.40	1.90	1.80	2.00	2.00	1.60	1.60	1.80	1.05	1.05	1.30
4	1.30	1.50	1.90	1.80	1.85	1.80	1.50	1.50	1.90	1.00	1.10	1.35
5	1.20	1.50	1.90	1.75	1.90	1.70	1.40	1.65	1.80	1.00	1.50	1.45
6	1.20	1.40	2.00	1.70	1.80	1.60	1.45	1.60	1.70	1.00	1.70	1.95
7	1.20	1.60	2.90	1.75	1.85	1.70	1.40	1.70	1.45	1.00	1.40	2.10
8	1.30	2.10	4.50	1.90	2.00	1.90	1.30	1.80	1.40	1.00	1.30	1.70
9	1.40	2.10	3.70	2.00	3.35	1.85	1.70	1.80	1.35	1.00	1.20	1.50
10	1.30	1.80	2.70	2.00	2.80	1.65	1.60	1.85	1.40	1.00	1.10	1.50
11	1.30	1.70	2.55	2.00	2.40	1.70	1.50	1.90	1.35	.95	1.00	1.50
12	1.40	1.60	2.30	1.90	2.20	1.65	1.40	2.00	1.40	1.00	1.10	1.45
13	1.70	1.50	2.15	1.90	2.00	1.60	1.30	1.90	1.40	1.00	1.20	1.40
14	1.60	1.40	2.10	1.80	1.95	1.50	1.30	1.70	1.35	.95	1.45	1.35
15	1.60	1.60	2.20	1.80	1.90	1.45	1.20	1.60	1.30	1.00	1.45	1.35
16	1.50	1.50	2.00	1.80	1.80	1.45	1.15	1.70	1.25	.95	1.40	1.30
17	2.00	1.50	1.90	1.80	1.75	1.40	1.15	1.55	1.20	.95	1.35	1.30
18	2.10	1.50	1.90	1.80	1.70	1.40	1.15	1.55	1.20	.90	1.30	1.35
19	2.10	1.40	1.95	1.70	1.70	1.85	1.20	1.50	1.15	.95	1.30	1.30
20	1.90	1.50	1.90	1.70	1.70	1.75	1.20	1.50	1.20	.95	1.25	1.25
21	1.90	1.60	2.00	1.75	1.65	1.70	1.40	1.50	1.15	1.00	1.25	1.30
22	2.00	1.80	2.20	1.80	1.60	1.75	1.30	1.50	1.20	.95	1.25	1.30
23	2.10	2.90	4.20	1.70	1.55	1.65	1.40	1.55	1.15	1.05	1.40	1.25
24	2.50	2.30	3.70	1.75	1.60	1.55	1.55	1.95	1.15	.95	1.30	1.30
25	1.90	2.00	3.10	1.70	1.65	1.45	1.85	1.70	1.15	1.00	1.25	1.35
26	1.80	1.90	2.80	1.75	1.60	1.50	1.50	1.75	1.10	1.00	1.25	1.35
27	1.60	2.20	2.75	2.15	1.60	1.60	1.50	.70	1.20	1.00	1.10	1.40
28	1.60	2.20	2.60	2.30	1.55	1.70	1.45	2.00	1.10	.95	1.00	1.60
29	1.50	2.00	2.30	2.20	1.50	1.90	1.40	1.95	1.15	1.00	1.10	2.25
30	1.40	.....	2.20	2.10	1.50	1.90	1.30	1.60	1.15	1.00	1.20	1.90
31	1.70	.....	2.10	.....	1.80	.....	1.30	1.50	.....	1.00	.....	1.60

Rating table for French Broad River at Oldtown, near Newport, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.9	400	1.9	2,410	2.8	5,140	3.7	8,805
1.0	535	2.0	2,680	2.9	5,500	3.8	9,245
1.1	685	2.1	2,955	3.0	5,875	3.9	9,690
1.2	850	2.2	3,235	3.1	6,260	4.0	10,140
1.3	1,030	2.3	3,525	3.2	6,660	4.1	10,590
1.4	1,225	2.4	3,825	3.3	7,075	4.2	11,050
1.5	1,435	2.5	4,135	3.4	7,500	4.3	11,510
1.6	1,660	2.6	4,455	3.5	7,930	4.4	11,980
1.7	1,900	2.7	4,790	3.6	8,365	4.5	12,450
1.8	2,150						

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904, and one measurement made during 1903 to determine the upper part of the curve. It is well defined between gage heights 1 foot and 3 feet.

Estimated monthly discharge of French Broad River at Oldtown, near Newport, Tenn., for 1904.

[Drainage area, 1,737 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,135	850	1,758	1.01	1.16
February	5,500	1,225	2,063	1.19	1.28
March	12,450	2,410	4,271	2.46	2.84
April	3,525	1,900	2,333	1.34	1.50
May	7,288	1,435	2,407	1.39	1.60
June	3,825	1,225	1,957	1.13	1.26
July	2,545	768	1,299	.748	.862
August	2,680	1,225	1,877	1.08	1.24
September	2,410	685	1,125	.648	.723
October	685	400	526	.303	.349
November	1,900	468	943	.543	.606
December	3,380	850	1,375	.792	.913
The year	12,450	400	1,828	1.05	14.33

SWANNANOA RIVER AT BILTMORE, N. C.

This station was established as a bench-mark station May 21, 1904, by B. S. Drane. It is located at the Biltmore, N. C., terminal of the Asheville-Biltmore electric railway line, about three-fourths mile above the mouth of Swannanoa River. Discharge measurements are made from the upstream side of a single-span highway bridge. The initial point for soundings is the right end of the upstream hand rail of the bridge. The channel is straight for about 1,000 feet above and curved for 300 feet below the station. The current is sluggish above and somewhat swifter below the bridge. Both banks are high and not subject to overflow. The bed of the stream is composed of sand. There is but one channel at all stages. Bench mark No. 1 is the center of the center-pin bearing at the upstream end of the second floor beam from the right bank. Its elevation is 16 feet above the datum of the gage. Bench mark No. 2 is the center of the head of a small wire nail driven into a triangular-shaped blaze in the downstream side of a birch tree on the right bank, about 25 feet above the bridge. Its elevation is 5.74 feet above the datum of the gage.

Discharge measurements of Swannanoa River at Biltmore, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
May 21	B. S. Drane	73	165	0.86	1.12	143
July 20	do	72	107	.35	.71	38
August 16	do	74	134	.75	.97	100

TENNESSEE RIVER NEAR KNOXVILLE, TENN.

This station was originally established by the United States Weather Bureau at the old county highway bridge, which has been torn down and replaced by a new bridge. Instead of placing the gage at the new bridge, it was decided to move it down the river in order to get below some shoals and wing dams which have been put in for boating. A temporary gage was put in at the Knoxville and Augusta Railroad bridge, a half mile below the highway bridge, and was used during the greater part of the year 1899. In the latter part of that year a new permanent gage was established, and readings from it began on November 1, 1899. The new gage is on the right bank of the river, just below the mouth of West Knoxville Bayou, and about 1,000 feet below the temporary gage at the Knoxville and Augusta Railroad bridge. The gage, which is graduated to feet and tenths, is in two sections—the first, a sloping section, made of a 2 by 4 inch pine tim-

ber spiked on top of an 8 by 8 inch oak sill well bolted to piles and embedded in crushed stone, reading from −2 to +12 feet; the second, a vertical section, attached to one of the bents of the railroad trestle across West Knoxville Bayou, about 50 feet from the bank of the river and from the sloping gage, reading from 12 to 36.5 feet. The gage is fastened to the upstream post of the bent, facing away from the river. The zero of the gage is 804.3 feet above sea level. The gage was located for the United States Weather Bureau by the United States Engineer Corps. Daily records are kept by the United States Weather Bureau and are furnished to the Geological Survey. Until recently discharge measurements have been made from the Cherokee Bridge, about 2½ miles downstream from the Gay street or county bridge, at which measurements are now made, and which is one-half mile above the Knoxville and Augusta Railroad bridge. The Gay Street Bridge has seven spans, with a total length of 1,570 feet. The floor of the bridge is about 100 feet above low water. The initial point for soundings is the end of the bridge on the right bank, downstream side. The channel is straight for one-half mile above and for 1,000 feet below the station. The right bank will overflow for about 400 feet and the left bank for 200 feet, beyond which points a steep high bluff begins on both sides of the river. The bed is of rocks and gravel, and is rough and probably permanent. The current is swift and somewhat broken by the rough bed and by the remains of old piers. The bench mark is a cross in the stone on the east corner of the base of the right-bank pier of the Knoxville and Augusta Railroad bridge. Its elevation is 2.4 feet above the zero of the gage and 806.7 feet above sea level.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tennessee River near Knoxville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 27	O. P. Hall	890	6,958	3.32	5.70	23,100
July 7	J. M. Giles	644	3,588	1.88	1.42	6,728
August 6	B. S. Drane	668	3,501	1.73	1.26	6,031
October 21	do	629	2,110	.86	− .36	1,813

Mean daily gage height, in feet, of Tennessee River near Knoxville, Tenn, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.80	0.80	3.80	3.20	4.50	1.10	3.10	0.70	0.60	−0.10	−0.30	0.40
2	.70	.80	3.50	3.40	3.70	2.70	2.70	.80	.50	− .10	− .30	.40
3	.50	.70	3.30	3.10	3.10	3.10	2.70	1.50	.50	− .20	− .30	.40
4	.50	.60	3.60	2.80	2.90	2.80	1.90	1.20	1.00	− .20	− .20	.40
5	.50	.60	3.20	2.60	2.70	2.10	1.50	1.40	1.00	− .20	− .20	.80
6	.20	.60	2.90	2.30	3.90	1.70	1.20	1.20	1.00	− .20	− .20	2.30
7	.10	.70	3.40	2.20	3.30	1.40	1.40	1.30	1.20	− .30	.40	3.20
8	.10	2.10	6.60	2.20	2.80	1.50	1.30	1.30	.80	− .30	.40	3.40
9	.20	2.60	8.30	2.50	3.00	1.60	1.20	1.50	.60	− .30	.30	2.20
10	.40	2.90	6.70	2.60	5.00	1.60	1.60	1.40	.50	− .30	.20	1.60
11	.40	2.50	5.40	2.70	4.80	1.30	1.50	1.50	.40	− .30	− .10	1.30
12	.40	2.00	4.90	2.40	3.80	1.20	2.00	1.50	.30	− .30	− .20	1.60
13	.60	1.70	4.20	2.20	3.30	1.40	1.60	1.70	.20	− .30	− .10	1.00
14	.90	1.30	3.90	2.00	2.90	1.20	1.10	1.80	.30	− .20	.00	.90
15	1.00	1.20	3.70	2.00	2.70	1.00	.90	1.60	.20	− .30	.20	.90
16	1.10	1.10	3.50	2.00	2.40	.90	.80	2.10	.20	− .30	.50	.80
17	1.00	1.10	3.10	3.00	2.30	.80	.80	1.40	.10	− .30	.60	.60
18	1.10	1.10	2.90	2.90	2.00	.70	.60	1.30	.00	− .30	.50	.60
19	1.30	1.00	2.70	2.10	1.90	.70	.70	1.20	.00	− .30	.30	.50
20	1.40	1.60	2.60	1.90	1.80	.90	.50	1.00	.00	− .30	.20	.50
21	1.10	1.90	2.80	1.90	1.80	1.30	.50	1.20	.00	− .30	.20	.40
22	1.00	2.50	4.50	1.90	1.70	1.00	.50	1.30	.00	− .30	.20	.30
23	1.80	3.70	7.30	2.00	1.50	1.00	.70	2.10	.00	− .30	.20	.20
24	2.60	4.80	12.00	1.90	1.40	1.00	.90	1.60	− .10	− .30	.30	.20
25	3.70	4.20	12.60	1.60	1.30	1.00	.90	1.60	− .10	− .40	.40	.50
26	2.80	3.20	10.10	1.70	1.20	.80	.80	1.50	− .20	− .40	.30	.70
27	2.00	5.20	8.30	1.80	1.10	1.10	.80	1.10	− .20	− .40	.30	.90
28	1.50	5.30	7.10	2.50	1.10	1.10	1.70	1.00	− .10	− .30	.20	3.50
29	1.20	4.70	6.10	4.30	1.00	1.40	1.30	1.10	− .10	− .30	.00	3.40
30	1.10	.....	5.00	5.40	1.00	2.30	.90	1.00	− .10	− .30	.10	3.60
31	.90	.....	4.20	.....	1.00	.....	.80	.80	.....	− .30	.....	2.50

Rating table for Tennessee River near Knoxville, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.4	1,750	1.1	5,500	3.2	12,950	8.0	33,440
− .3	1,930	1.2	5,820	3.4	13,710	8.5	35,840
− .2	2,120	1.3	6,150	3.6	14,480	9.0	38,290
− .1	2,320	1.4	6,480	3.8	15,260	10.0	43,340
.0	2,530	1.5	6,820	4.0	16,040	11.0	48,590
.1	2,750	1.6	7,160	4.2	16,840	12.0	54,040
.2	2,980	1.7	7,500	4.4	17,640	13.0	59,690
.3	3,220	1.8	7,850	4.6	18,450	14.0	65,490
.4	3,470	1.9	8,200	4.8	19,270	15.0	71,290
.5	3,730	2.0	8,550	5.0	20,090	16.0	77,090
.6	4,000	2.2	9,260	5.5	22,190	18.0	88,690
.7	4,280	2.4	9,980	6.0	24,340	20.0	100,290
.8	4,570	2.6	10,710	6.5	26,540	22.0	111,890
.9	4,870	2.8	11,450	7.0	28,790	25.0	129,290
1.0	5,180	3.0	12,190	7.5	31,090		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1900 to 1904, inclusive. It is well defined. Above gage height 0.4 feet the curve is the same as that for 1903.

nated monthly discharge of Tennessee River near Knoxville, Tenn., for 1904.

[Drainage area, 8,990 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	14,870	2,750	5,545	0.617	0.711
y	21,350	4,000	9,377	1.04	1.12
.....	57,410	10,710	21,770	2.42	2.79
.....	21,770	7,160	10,420	1.16	1.29
.....	20,090	5,180	10,430	1.16	1.34
.....	12,570	4,280	6,516	.725	.809
.....	12,570	3,730	6,095	.678	.782
.....	8,900	4,280	6,323	.703	.810
er	5,820	2,120	3,258	.362	.404
.....	2,320	1,750	1,968	.219	.252
er	4,000	1,930	2,852	.317	.354
er	14,480	2,980	6,309	.702	.809
ie year	57,410	1,750	7,572	.842	11.47

TENNESSEE RIVER AT CHATTANOOGA, TENN.

station was established in 1879, at the foot of Lookout street, low Chattanooga Island, by the Signal Corps of the United Army; but since July 1, 1891, it has been in charge of the er Bureau. The gage consists of a sloping section made of l rails bolted to solid rock, and a vertical section of heavy timted to the vertical face of rock cliff. During the year 1900 a ge was established. It is a vertical metal scale bolted to the ide of the third stone pier from the south end of the Hamilton highway bridge. The original sloping gage, however, is still red standard as the later gage is not properly adjusted at its nd on account of the projecting base of the pier. During the year the self-registering gage invented by Professor Fulton, nessee University, has been in use at this station. The gage is ted by wire with the Weather Bureau office, and a continuous al record of river height is made in the same manner as the of wind, sunshine, etc. Gage heights are furnished to the ical Survey through L. M. Pindell.

arge measurements are made from the steel highway bridge pans and an approach about 1,000 feet long on the right bank. or of the bridge is about 125 feet above low water. The initial or soundings is the outside corner of the iron post of the downhand rail on the left bank. The channel is curved for 3,000

feet above and 2,000 feet below the station. The right bank is high and overflows at flood stages, but all water passes under the bridge or its approach. The left bank is a high, rocky bluff, and will not overflow. The bed is composed of loose rock, sand, and gravel, and is fairly constant. The bench mark is the top of the water table on the southeast corner of the post-office on Eleventh street. Its elevation is 74.4 feet above the zero of the gage, and 705 feet above sea level.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tennessee River at Chattanooga, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 3	J. M. Giles	975	7,395	2.23	2.77	16,480
February 10	do	1,054	10,610	3.36	5.85	35,640
April 19	do	993	8,493	2.94	4.30	24,980
July 6	do	956	6,920	2.54	3.18	17,590
August 5	B. S. Drane	1,114	7,014	2.10	2.73	14,710
October 13	do	1,014	4,375	1.23	.21	5,368
October 14	do	1,016	4,433	1.25	.22	5,558
October 22	do	1,012	4,234	1.15	.06	4,863

Mean daily gage height, in feet, of Tennessee River at Chattanooga, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.10	3.40	8.10	9.00	6.00	4.30	3.60	2.20	2.20	0.70	0.10	1.10
2	2.60	3.10	7.40	8.10	7.60	4.10	3.70	2.20	2.00	.70	.10	1.40
3	2.30	2.80	7.00	7.20	6.70	4.30	4.30	2.60	1.80	.60	.20	1.70
4	2.20	2.70	6.60	6.60	5.80	4.40	4.00	2.40	1.80	.50	.40	2.20
5	2.00	2.50	6.10	6.00	5.40	4.90	3.90	2.60	1.70	.40	.50	2.10
6	2.00	2.40	6.20	5.60	5.20	4.90	3.40	2.90	1.70	.50	.50	3.50
7	1.70	2.30	6.10	5.40	4.90	4.50	3.10	3.70	2.20	.40	.60	4.40
8	1.60	3.60	8.00	5.40	5.40	3.80	2.90	3.70	2.40	.30	.60	5.80
9	1.50	4.80	11.00	5.80	5.60	3.70	2.70	3.30	2.20	.20	.60	5.70
10	1.60	5.90	11.30	5.90	6.40	3.70	2.90	3.30	2.00	.30	.90	5.40
11	1.70	5.40	11.10	6.00	7.00	3.40	2.90	3.30	1.80	.30	.90	4.20
12	1.70	5.50	10.10	5.60	7.20	3.20	3.10	3.30	1.60	.30	.90	3.50
13	1.90	4.90	9.00	5.30	6.60	2.80	3.10	4.10	1.40	.30	.80	3.00
14	2.10	4.40	8.50	4.90	5.70	2.60	3.60	3.70	1.30	.20	.60	2.70
15	2.30	3.90	9.10	4.70	5.40	2.50	3.40	3.30	1.20	.20	.60	2.50
16	2.50	3.60	8.90	4.40	5.20	2.50	3.00	3.30	1.10	.20	.70	2.40
17	2.60	3.50	8.10	4.30	4.90	2.40	2.60	4.10	1.00	.20	.80	2.30
18	2.90	3.30	7.10	4.30	4.50	2.20	2.40	3.90	1.00	.20	.90	2.10
19	3.90	3.10	6.60	4.30	4.30	2.10	2.20	3.10	.90	.20	1.00	2.00
20	3.80	3.20	6.10	4.20	4.10	2.00	2.10	2.70	.90	.20	1.10	1.80
21	3.60	3.70	5.80	4.10	3.80	2.00	1.80	2.40	.90	.10	1.00	1.70
22	3.60	5.20	7.40	4.00	3.60	2.10	1.70	2.40	.80	.10	1.00	1.60
23	6.00	6.30	12.90	4.00	3.50	2.60	1.90	2.20	.80	.10	.90	1.50
24	10.60	7.90	18.20	4.00	3.40	2.70	2.20	2.20	.80	.10	1.00	1.40
25	9.20	8.10	21.80	4.00	3.10	2.30	2.10	2.90	.80	.10	1.00	1.40
26	7.50	7.90	20.90	3.80	2.90	2.30	2.00	3.00	.70	.10	1.00	2.00
27	7.10	7.10	19.10	3.70	2.80	2.20	2.20	2.80	.60	.10	1.10	3.00
28	5.80	7.30	16.90	4.10	2.70	2.20	2.40	2.60	.60	.10	1.00	7.30
29	4.80	9.00	14.00	4.60	2.70	2.70	2.10	2.60	.60	.10	1.00	10.20
30	4.20	.....	11.80	4.70	2.60	3.40	2.60	2.50	.60	.10	1.00	9.60
31	3.80	.....	10.30	.....	3.00	.....	2.90	2.30	.....	.10	.....	7.60

DAVIDSONS RIVER NEAR DAVIDSONS RIVER, N. C.

This station was established May 19, 1904, by M. R. Hall. It is ocated at English Bridge, about 2 miles from Davidsons River, N. C., nd about 500 feet above the mouth of Avery Creek. The gage is a -inch by 4-inch pine timber fastened to a 2½-inch by 4-inch oak scant- ng, which is spiked to the downstream side of a maple tree on the left ank, 40 feet below the bridge. It is graduated to feet and tenths and ; 10 feet long. The gage is read once each day by J. J. Perry. Discharge measurements are made from the single-span wooden high- ay bridge, with log abutments. The floor of the bridge is about 2 feet above low water. The initial point for soundings is the edge f the wooden crib abutment on the upstream side at the left bank. 'he channel is straight for about 500 feet above and below the station. 'he current is moderately swift. The right bank is high, rocky, ooded, and is not subject to overflow. The left bank is low, but is ot subject to overflow. The bed of the stream is composed of rock, ostly loose bowlders and shingle, and is clean and permanent. There ; but one channel at all stages. Bench mark No. 1 is two wire nails riven into the downstream side of the tree to which the gage is ttached. Its elevation is 4 feet above the zero of the gage. Bench ark No. 2 is a cross cut on the top of solid rock at edge of water, 8 eet below the bridge at right bank. Its elevation is 1.48 feet above he zero of the gage. Bench mark No. 3 is the center of a nail head in hird log from bottom of crib at the right bank on the upstream side. ts elevation is 7 feet above the zero of the gage.

The observations at this station during 1904 have been made under he direction of M. R. Hall, district hydrographer.

Discharge measurements of Davidsons River near Davidsons River, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
pril 20	M. R. Hall	65	105	0.79	1.00	83
lay 19	B. S. Drane	66	108	.77	1.05	84
uly 19	do	64	88	.46	.78	41
uly 19	do	64	86	.47	.78	41
ugust 17	do	68	99	.72	.99	71
ctober 4	do	63	86	.47	.79	40
ecember 8	do	63	88	.57	.85	51
ecember 8	do	63	88	.62	.85	55

Mean daily gage height, in feet, of Davidsons River near Davidsons River, N. C., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.05	0.85	1.05	1.10	0.80	0.75	0.75
2	1.10	.85	1.00	1.10	.80	.75	.75
3	1.05	.80	.90	1.05	.80	.90	.80
4	1.00	.80	1.00	1.05	.80	1.20	.80
5	.95	.80	.90	1.05	.80	1.00	1.15
6	.95	.80	.90	1.00	.80	.80	1.05
7	1.15	.85	.90	1.00	.80	.80	.90
8	1.05	.90	1.10	.95	.80	.80	.85
9	1.00	.85	1.00	1.00	.80	.75	.85
10	.95	.85	1.45	.95	.75	.75	.85
11	1.10	.90	1.50	1.00	.75	.75	.80
12	1.00	.90	1.40	1.00	.75	.75	.80
13	1.00	.90	1.25	1.00	.75	1.10	.80
14	.95	.90	1.10	.95	.75	.85	.80
15	.90	.80	1.05	.95	.75	.80	.80
16	.90	.75	1.05	.90	.75	.80	.80
17	1.00	.85	1.00	.90	.75	.80	.80
18	.95	.80	.95	.90	.75	.80	.80
19	.95	.90	.90	.90	.75	.75	.80
20	.95	1.00	.90	.85	.75	.75	.80
21	.90	1.05	.95	.85	.75	.75	.80
22	.95	.90	1.05	.85	.75	.75	.80
23	.90	.90	1.15	.85	.75	.75	.80
24	.90	.85	1.25	.85	.75	.75	.80
25	.90	.90	1.65	.85	.75	.75	.85
26	.90	.85	1.60	.85	.75	.75	.80
27	.85	.85	1.55	.85	.75	.75	1.30
28	.85	.80	1.40	.85	.75	.75	1.30
29	.95	1.00	1.25	.80	.75	.75	1.10
30	.90	.90	1.20	.80	.75	.80	1.05
31	.....	.95	1.10	.....	.75	.....	1.00

AVERY CREEK AT DAVIDSONS RIVER, N. C.

This station was established as a bench-mark station May 19, 1904, by M. R. Hall. It is located about one-fourth mile above the junction of Avery Creek with Davidsons River and a less distance from the regular gaging station on the latter stream. Discharge measurements are made from the foot log just above the wagon bridge, the section being smoother than that under bridge. The initial point for soundings is the edge of the large rock which forms the left bank. The channel is curved for about 100 feet above the station and straight for 50 feet below, when it curves to the right. The current is swift. The right bank is high, wooded, and not liable to overflow. The left bank is low, wooded, and overflows at high stages. The bed of the stream is rocky along the right bank and sandy for the remainder. It is not liable to change. There is but one channel at all stages. The bench mark is a small shelf chipped in the upper edge of the upstream face of the large rock on the right bank upon which the end of the foot log rests. Its elevation is 5 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Avery Creek at Davidsons River, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 19	B. S. Drane	18	16	0.91	1.79	14.0
July 19	do	18	13	.64	1.63	8.0
August 17	do	18	14.5	1.00	1.77	14.5
October 4	do	18	12.5	.55	1.62	6.8
December 8	do	18	12	.52	1.66	6.3

LITTLE RIVER AT CALHOUN, N. C.

This station was established as a bench-mark station July 19, 1904, by B. S. Drane. It is located at the highway bridge about one-fourth mile from Calhoun post-office, N. C., and about 1 mile above the mouth of Little River. Discharge measurements are made from the upstream side of the two-span wooden bridge. The initial point for soundings is the right end of the upstream guard rail. The channel is curved for about 75 feet above and 100 feet below the station. The current is swift. The right bank is a high rock cliff; the left bank is composed of earth, steep and wooded. Neither bank is liable to overflow. The bed of the stream is composed of rock along the right bank, and of sand for the greater part of the distance. There is one channel at all stages. Possibly a freshet in French Broad River would make a sluggish back water at this station, but this is not liable to occur. Bench mark No. 1 is the upstream end of the horizontal strap binding the upstream guard rail to the girder, 31 feet from the initial point for soundings. Its elevation is 16 feet above datum. Bench mark No. 2 is the upper edge of a small ledge of rock overhanging the water just under a point on the upstream side of the bridge, 6 feet from the initial point for soundings. It is marked by a nick in the rock on either side. Its elevation is 3 feet above datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Little River at Calhoun, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 19	B. S. Drane	36	43	1.16	0.59	50
August 17	do	37	73	1.27	1.00	93
December 8	do	33	67	1.28	1.09	86

MILLS RIVER (NORTH FORK) AT PINKBED, N. C.

This station was established May 18, 1904, by M. R. Hall. It is located at wagon bridge in the village of Pinkbed, N. C., about three fourths mile below the post-office of that name. The gage is a vertical 1-inch by 4-inch pine timber fastened to a 2-inch by 4-inch oak scantling which is spiked to the log crib on right bank, at upper side of bridge. The gage is 10 feet long, and is graduated to feet and tenths. It is read once each day by C. D. Davenport. Discharge measurements are made from the single, 39-foot span, wagon bridge to which the gage is attached. The bridge rests upon log crib abutments, and the floor is about 10 feet above low water. The initial point for soundings is the edge of crib abutment at the left bank, on the downstream side of the bridge. The channel is straight for about 200 feet above and below the station. The current is swift. Both banks are about 10 feet above low water, and are not liable to overflow. There is a wide, level stretch of land from the left bank to foot of hill. The bed of the stream is composed of loose rock and is probably permanent. There is but one channel at all stages. Bench mark No. 1 is a nail driven in bottom log of crib on right bank at downstream corner of crib. Its elevation is 1.70 feet above the zero of the gage. Bench mark No. 2 is the center of a nail driven in a notch on a small poplar tree on left bank about 40 feet above bridge. Its elevation is 5.70 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Mills River (North Fork) at Pinkbed, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 21	M. R. Hall	36	27	1.45	0.70	39.4
May 18	B. S. Drane	37	31	1.61	.82	50.6
July 18	do	34	22	1.23	.56	27.0
August 18	do	34	23	1.40	.64	33.0
October 3	do	29	17	1.11	.47	18.0
October 3	do	29	17	1.01	.47	17.0
December 9	do	33	19	1.17	.52	22.0
December 9	do	33	19	1.08	.52	20.0

ly gage height, in feet, of Mills River (North Fork) at Pinkbed, N. C., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	0.80	0.60	0.85	0.60	0.45	0.45	0.45
	.85	.55	.65	.65	.45	.45	.45
	.80	.55	.60	.55	.45	.55	.50
	.70	.50	.65	.55	.45	.90	.50
	.70	.50	.65	.90	.45	.80	.60
	.65	.50	.70	.70	.45	.50	.70
	.90	.50	.75	.65	.45	.50	.60
	.75	.50	.95	.60	.45	.50	.50
	.70	.90	.80	.60	.45	.45	.50
	.70	.70	.85	.55	.45	.45	.55
	.70	.70	1.35	.60	.45	.45	.50
	.65	.65	1.15	.60	.45	.45	.50
	.60	.60	.90	.60	.45	1.00	.50
	.60	.55	.80	.55	.45	.50	.50
	.60	.55	.75	.55	.45	.50	.50
	.60	.55	.70	.55	.45	.50	.50
	.70	.70	.70	.55	.45	.50	.50
	.70	.65	.65	.50	.45	.50	.50
	.70	.55	.60	.50	.45	.50	.45
	.85	.50	.65	.50	.45	.50	.60
	.70	.55	.60	.50	.45	.50	.60
	.75	.55	.60	.50	.45	.50	.60
	.65	.60	.60	.50	.45	.50	.45
	.60	.55	.65	.50	.45	.45	.50
	.60	.55	.65	.50	.45	.45	.50
	.55	.60	.60	.50	.45	.45	.50
	.60	.55	.80	.50	.45	.45	.70
	.65	.55	.75	.50	.45	.45	1.00
	.65	.55	.65	.45	.45	.45	.70
	.65	.55	.55	.45	.45	.45	.70
	.....	.55	.60	.....	.45	.....	.55

ible for Mills River (North Fork) at Pinkbed, N. C., from June 1 to December 31, 1904.

Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Second-feet.	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
16	0.70	39	0.95	65	1.20	95
20	.75	44	1.00	71	1.25	101
24	.80	49	1.05	77	1.30	107
29	.85	54	1.10	83	1.35	113
34	.90	59	1.15	89		

bove table is applicable only for open-channel conditions. It is based upon rge measurements made during 1904. It is well defined between gage heights and 0.85 feet. The table has been extended above gage height 0.85 feet.

Estimated monthly discharge of Mills River (North Fork) at Pinkbed, N. C., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
June	59	24	37.8
July	59	20	27.1
August	113	24	42.9
September	59	16	25.3
October	16	16	16.0
November	71	16	22.4
December	71	16	25.3

MILLS RIVER (SOUTH FORK) NEAR SITTON, N. C.

This station was established May 18, 1904, by M. R. Hall. It is located at Sycamore Church, about 1 mile below Sitton's mill, Sitton, N. C. The gage is a vertical 1 by 4 inch pine timber, 10 feet long, graduated to feet and tenths, fastened to a 2 by 4 inch chestnut scantling, which is spiked to a whiteoak tree on the right bank of the river about 40 feet above foot log. The gage faces upstream and can be easily read from the bank. It is read once each day by W. E. Field. Discharge measurements are made from a foot log about 150 feet above ford. The channel above curves about 90 degrees in 500 feet above and is straight for 200 feet below the station. The current is moderately swift, but may be rather sluggish above the station at low stages. Both banks are high and clean and are subject to overflow at extreme high water. The bed of the stream is composed of rock, and is clean and constant. There is but one channel at all stages. Owing to the overflowing of the banks discharge measurements can not be made at high water. Bench mark No. 1 is the center of two nail heads driven into the tree to which the gage is attached, on the side next the river. Its elevation is 5 feet above the zero of the gage. Bench mark No. 2 is the center of nails in root of whiteoak tree on the right bank, 15 feet below the foot log. Its elevation is 5 feet above the zero of the gage. Bench mark No. 3 is nails driven into a beech tree on the right bank about 50 feet below the foot log. Its elevation is 8 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

River (South Fork) near Sitton, N. C., in 1904.

Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
47	79	1.04	1.00	82
41	79	1.21	1.09	96
40	68	.72	.81	49
41	74	.93	.98	69
41	65	.56	.76	36
41	65	.54	.76	35
40	66	.72	.82	47
40	66	.74	.82	49

River (South Fork) near Sitton, N. C., for 1904.

June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.20	1.05	1.10	1.15	0.75	0.70	0.80
1.20	.95	.90	1.05	.75	.75	.80
1.05	.90	.85	1.00	.75	.85	.80
1.00	.90	.90	1.90	.75	1.25	.80
.95	.90	.90	1.15	.75	1.00	1.15
.90	.85	.90	1.00	.75	.90	1.15
1.65	.85	1.00	.95	.75	.80	.90
1.10	.85	1.10	.90	.75	.80	.85
1.00	1.30	1.05	.90	.75	.80	.80
.95	1.00	1.10	.95	.75	.75	.80
1.15	.95	1.80	1.10	.75	.75	.80
1.00	.90	1.65	.95	.75	.75	.80
.95	.90	1.30	1.00	.75	1.10	.80
.90	.85	1.10	.90	.70	.90	.70
1.00	.80	1.05	.90	.70	.80	.80
.95	.80	1.25	.90	.70	.80	.80
1.05	.90	1.00	.85	.70	.80	.80
.95	.80	1.00	.85	.70	.80	.80
.95	.80	.95	.85	.70	.80	.80
1.10	1.45	1.00	.80	.70	.80	1.00
.95	.85	.90	.80	.70	.80	1.00
1.00	.90	1.10	.80	.70	.80	1.00
.90	.95	1.00	.80	.70	.80	.80
.90	.90	.95	.80	.70	.80	.80
1.10	.90	1.45	.80	.70	.75	.80
1.10	1.00	1.20	.80	.70	.75	.80
.90	.90	1.50	.80	.75	.75	1.10
1.10	.85	1.30	.80	.70	.75	1.40
1.35	.80	1.10	.80	.70	.75	1.10
1.20	.85	1.05	.80	.70	.80	1.00
.....	.85	1.00	.....	.70	.....	1.00

Provisional rating table for Mills River (South Fork) near Sitton, N. C., from June 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*
0.7	22	1.0	82
.8	42	1.1	102
.9	62		

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1904. It is well defined between gage heights 0.75 feet and 1.10 feet, and can only be considered roughly approximate above 1.1 feet. The rating curve is a tangent, the difference being 20 per tenth.

Estimated monthly discharge of Mills River (South Fork) near Sitton, N. C., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
June	212	62	92.0
July	172	42	65.5
August	242	52	104
September	262	42	69.0
October	32	22	26.5
November	132	22	46.3
December	162	22	61.0

PIGEON RIVER AT NEWPORT, TENN.

The station was established September 4, 1900, by E. W. Myers. It is located at the highway bridge in the eastern part of Newport, Tenn., 1 mile from the railroad station and 1 mile above the dam of the Newport Flouring Mill, out of reach of backwater. On April 30, 1903, the old wire gage was replaced by a standard chain gage with inclosed scale fastened to the lower chord of the bridge on the downstream side, approximately at the same location as the old gage. The new gage was made to read the same as the one which it replaced. The gage is read once each day by S. R. McSween. Since it was first established the gage has been damaged several times, and the records are continuous only from December 14, 1902. Discharge measurements are made from the lower side of the single-span steel highway bridge to which the gage is attached. The initial point for soundings is the end of the hand rail over the left bank on the downstream side of the bridge. The channel is straight for about 300 feet above and

feet below the station. The section is deep, rough, and irregular ıape; the velocity is poorly distributed and about 50 feet of the l width at low stages is stillwater or has a negative velocity. The ion is better for measuring at the Southern Railway bridge, about feet below, at which point some of the measurements have been e. The right bank is low and overflows to some extent, but all ɜr passes beneath the bridge and its approach. The left bank is a ı vertical rock cliff. The bed of the stream is rocky near the left k and sandy near the right bank.

ench mark No. 1 is the top surface of the outer left corner of the e at the bottom of the floor-beam hanger to the left of the zero of gage. When the gage reads zero the water surface is 26.87 feet ›w this bench mark. Bench mark No. 2 is the top of a copper plug in cement on the top of a limestone outcrop about 5 feet upstream 3 feet to the left of the end of the upstream hand rail on the left k. When the gage reads zero the water surface is 32.61 feet below top of the bolt.

he observations at this station during 1904 have been made under direction of M. R. Hall, district hydrographer.

Discharge measurements of Pigeon River at Newport, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
uary 22	B. S. Drane	159	1,203	1.72	2.68	2,070
·h 29	do	150	1,132	1.57	2.45	1,775
l 26	do	143	992	.87	1.68	861
8	J. M. Giles	110	835	.77	1.27	642
ıst 20	B. S. Drane	134	854	.50	1.10	425
ıst 20[a]	do	228	585	.84	1.10	490
ber 15	do	125	783	.21	.62	169
ber 15[a]	do	221	443	.49	.62	216

[a] At railroad bridge.

Mean daily gage height, in feet, of Pigeon River at Newport, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.15	1.90	2.00	1.85	1.80	1.60	1.10	1.15	0.70	0.60	1.10
2	1.05	1.10	1.85	1.90	1.80	1.70	1.45	1.50	1.25	.65	.60	1.00
3	1.10	1.10	1.80	1.85	1.75	1.65	1.20	1.10	1.20	.65	.65	.90
4	1.00	1.05	1.70	1.80	1.80	1.50	1.20	1.20	1.25	.65	.80	1.00
5	.70	1.10	1.65	1.75	1.75	1.30	1.20	1.40	1.25	.65	1.05	1.20
6	.50	1.15	1.60	1.70	1.70	1.50	1.30	1.55	1.30	.70	.95	2.40
7	1.15	1.50	6.30	1.75	1.60	1.70	1.45	1.50	1.15	.65	.85	1.60
8	1.00	2.40	3.10	1.90	2.00	1.85	1.30	1.30	1.00	.65	.80	1.25
9	.95	2.00	2.50	2.50	2.70	1.50	2.25	1.40	1.00	.65	.70	1.10
10	1.00	1.75	2.35	2.00	2.25	1.35	1.75	1.50	1.00	.65	.65	1.05
11	1.10	1.55	2.30	1.80	2.00	1.30	1.45	1.55	.95	.60	.65	1.00
12	1.25	1.50	2.30	1.75	1.95	1.35	1.75	1.60	.95	.60	.60	1.00
13	1.20	1.40	2.10	1.70	1.90	1.35	1.50	1.70	.95	.60	.70	1.00
14	1.10	1.40	2.05	1.60	1.85	1.25	1.25	1.40	.90	.60	.80	.95
15	1.10	1.35	2.00	1.65	1.80	1.20	1.25	1.35	.85	.60	.90	.90
16	1.15	1.30	2.00	1.70	1.70	1.20	1.15	1.40	.80	.55	.85	.90
17	1.15	1.30	1.90	1.70	1.60	1.15	1.30	1.15	.80	.55	.80	.90
18	1.15	1.30	1.90	1.65	1.60	1.20	1.20	1.05	.80	.55	.80	.85
19	1.15	1.30	1.90	1.60	1.55	1.20	1.10	1.05	.80	.55	.75	.85
20	1.20	1.40	1.80	1.50	1.50	1.30	1.00	1.10	.80	.60	.75	.70
21	1.25	1.40	2.00	1.75	1.45	1.50	1.00	1.10	.75	.60	.80	.65
22	2.65	2.65	2.50	1.85	1.35	1.40	1.40	1.15	.75	.55	.80	.65
23	3.15	2.25	5.10	1.75	1.35	1.40	1.50	1.50	.75	.55	.90	.60
24	2.00	1.85	2.30	1.60	1.35	1.20	1.45	1.40	.70	.55	1.00	.90
25	1.75	1.20	2.20	1.60	1.40	1.25	1.40	1.30	.70	.60	.90	.95
26	1.60	1.65	2.80	1.60	1.40	1.25	1.30	1.40	.70	.60	.80	1.00
27	1.50	2.70	2.95	1.95	1.35	1.35	1.20	1.30	.75	.60	.75	1.05
28	1.40	2.20	2.75	2.00	1.30	1.45	1.05	1.25	.75	.60	.75	3.05
29	1.30	2.00	2.45	2.00	1.25	1.50	1.00	1.20	.75	.60	.75	1.90
30	1.25	.....	2.30	2.00	1.20	1.70	1.00	1.15	.70	.60	1.20	1.70
31	1.20	.....	2.15	.....	2.20	.....	1.05	1.10	.....	.60	.....	1.40

Rating table for Pigeon River at Newport, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.6	180	1.5	710	2.4	1,660	3.3	3,300
.7	225	1.6	790	2.5	1,810	3.4	3,500
.8	275	1.7	875	2.6	1,970	3.5	3,700
.9	325	1.8	965	2.7	2,140	3.6	3,900
1.0	380	1.9	1,060	2.8	2,320	3.7	4,100
1.1	440	2.0	1,160	2.9	2,510	3.8	4,300
1.2	500	2.1	1,270	3.0	2,700	3.9	4,500
1.3	565	2.2	1,390	3.1	2,900	4.0	4,700
1.4	635	2.3	1,520	3.2	3,100	5.0	6,700

The above table is based upon measurements made 1900 to 1904, and is well defined. Above gage height 3 feet the rating curve is a tangent, the difference being 200 per tenth.

Estimated monthly discharge of Pigeon River at Newport, Tenn., for 1904.

[Drainage area, 655 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,000	140	635	0.969	1.12
February	2,140	410	846	1.29	1.39
March	9,300	790	1,859	2.84	3.27
April	1,810	710	974	1.49	1.66
May	2,140	500	895	1.37	1.58
June	1,012	470	653	.997	1.11
July	1,455	380	598	.913	1.05
August	875	410	583	.890	1.03
September	565	225	340	.519	.579
October	225	160	184	.281	.324
November	500	180	275	.420	.469
December	2,800	180	529	.808	.932
The year	9,300	140	698	1.07	14.51

NOLICHUCKY RIVER NEAR GREENEVILLE, TENN.

This station was established May 7, 1903, by E. W. Myers, assisted by B. S. Drane. It is located at Jones's bridge, 5 miles southeast of Greeneville, Tenn., which is the nearest railroad station. The standard chain gage, with inclosed scale, is nailed to wooden blocks bolted to the lower chord of the bridge on the upstream side midway between the second and third intermediate post from the right bank. The length of the chain from the end of the weight to the marker is 33.63 feet. The gage is read once each day by B. H. Jones. Discharge measurements are made from the downstream side of the two-span steel highway bridge to which the gage is attached. The initial point for soundings is the left end of the top bar of the downstream hand rail. The channel is straight for about 700 feet above and below the station. The right bank is high, but at flood stages part of the water will pass around the end of the bridge. The left bank is high and can never overflow. The section is regular, and the bed is composed of pebbles and small stones and is not subject to change. The velocity is uniform and well distributed except at extreme low water (below gage height 0.50 foot), when the middle pier and a small bar of gravel and small stones throw the current toward both banks.

Bench mark No. 1 is a standard iron bench-mark post of the United States Geological Survey set on the left bank just below the bridge. It is 5.5 feet downstream from the left end of the bridge, and is said

to be above high-water mark. Its elevation above gage datum is 26.80 feet. Bench mark No. 2 is the upper outer edge of the outer eyebar of the lower chord of the bridge, 3.6 feet to the right of the center of the third intermediate post from the right bank. The point is marked by a spot of white paint and the letters "B. M." Its elevation above gage datum is 32.03 feet.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Nolichucky River near Greeneville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 24	B. S. Drane	275	1,015	1.57	1.11	1,592
February 27	do	274	1,157	2.21	1.69	2,529
March 23	do	275	1,558	3.45	3.26	5,383
March 23	do	275	1,732	3.84	3.66	6,657
March 24	do	311	2,008	3.99	4.67	8,018
May 3	do	133	987	1.56	1.11	1,542
July 9	J. M. Giles	264	806	1.07	.48	859
August 9	B. S. Drane	275	911	1.24	.81	1,129
August 9	do	275	914	1.34	.82	1,222
October 17	do	275	649	.52	−.12	340
October 17	do	275	646	.55	−.10	355

Mean daily gage height, in feet, of Nolichucky River near Greeneville, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.11	0.20	1.40	1.40	1.40	1.75	1.30	0.30	0.25	0.00	−0.10	0.30
2	.12	.20	1.40	1.40	1.25	1.95	.90	1.45	.50	−.05	−.05	.25
3	.30	.18	1.30	1.25	1.15	1.55	.65	.95	.65	−.10	−.05	.30
4	.18	.30	1.20	1.05	1.20	1.15	.50	.65	.60	−.05	.00	.30
5	.06	.20	1.20	1.00	1.40	.95	.70	.50	.50	−.10	.25	.60
6	.10	.15	1.00	.95	1.20	.85	.50	.65	.40	−.10	.55	1.05
7	.04	.30	3.10	1.00	1.05	.90	.50	.60	.30	−.10	.30	1.20
8	.12	1.80	3.70	1.00	.90	.80	.45	.70	.25	.00	.10	.75
9	.11	1.40	2.40	.95	3.70	.75	.50	.80	.20	−.05	.05	.50
10	.09	.90	1.80	1.15	2.30	.60	1.00	.65	.15	−.05	.00	.45
11	.12	.70	1.65	.95	1.70	.85	.65	.75	.15	−.05	.00	.50
12	.20	.60	1.60	.90	1.45	.75	.85	1.05	.15	−.05	.00	.55
13	.30	.40	1.40	.90	1.35	.70	.65	.80	.15	−.10	.10	.50
14	.30	.40	1.25	.80	1.15	.55	.50	.65	.20	−.10	.55	.35
15	.19	.40	1.25	.75	1.05	.50	.35	.50	.10	−.10	.55	.30
16	.10	.60	1.10	.80	1.00	.40	.30	.65	.10	−.10	.30	.30
17	.30	.40	.95	1.20	.90	.45	.35	.60	.05	−.10	.25	.35
18	.70	.30	.95	1.00	.85	.55	.35	.55	.05	−.10	.30	.30
19	.50	.40	1.05	.85	.95	.65	.25	.40	.05	−.10	.20	.30
20	.30	.50	1.00	.80	.85	.75	.20	.55	.05	−.10	.15	.30
21	.30	.60	.95	.80	.80	.75	.20	.75	.05	−.10	.20	.30
22	.30	.60	2.10	.80	.75	.70	.70	.90	.05	−.10	.20	.30
23	1.00	1.70	2.10	.75	.65	.55	.45	.65	.00	−.15	.25	.15
24	1.00	1.20	5.00	.75	.60	.45	.30	.75	.00	−.10	.40	.15
25	.90	.90	3.30	.80	.60	.40	.25	1.00	.00	−.10	.30	.30
26	.50	.90	2.50	.75	.60	.50	.90	.55	.00	−.10	.20	.30
27	.40	1.50	2.40	1.50	.70	.85	.70	.45	.00	−.10	.15	.50
28	.30	2.20	2.30	2.25	.65	.60	.40	.45	.00	−.05	.10	.70
29	.30	1.60	1.90	1.90	.55	1.95	.45	.35	.00	−.05	.05	1.35
30	.30	.....	1.70	1.65	.55	1.55	.50	.30	.00	−.05	.20	.80
31	.20	.....	1.50	.....	.60	.....	.45	.25	.00	−.10	.....	.35

ting table for Nolichucky River near Greeneville, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.15	320	0.8	1,195	1.9	2,780	3.0	4,860
−.1	355	.9	1,305	2.0	2,955	3.2	5,270
−.05	390	1.0	1,420	2.1	3,135	3.4	5,680
.0	430	1.1	1,545	2.2	3,315	3.6	6,100
.1	510	1.2	1,675	2.3	3,500	3.8	6,530
.2	595	1.3	1,815	2.4	3,685	4.0	6,960
.3	685	1.4	1,965	2.5	3,875	4.2	7,390
.4	780	1.5	2,120	2.6	4,070	4.4	7,820
.5	880	1.6	2,280	2.7	4,265	4.6	8,250
.6	980	1.7	2,445	2.8	4,460	4.8	8,690
.7	1,085	1.8	2,610	2.9	4,660	5.0	9,130

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between ge heights −0.15 feet and 1.10 feet. Above 1.10 feet the curve is somewhat uncer- in owing to the fluctuation of the water surface during the high-water measurements.

Estimated monthly discharge of Nolichucky River near Greeneville, Tenn., for 1904.

[Drainage area, 1,099 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
nuary	1,420	462	711	0.647	0.746
bruary	3,315	553	1,210	1.10	1.19
arch	9,130	1,363	2,778	2.53	2.92
ril	3,408	1,140	1,549	1.41	1.57
ay	6,315	930	1,631	1.48	1.71
ne	2,868	780	1,313	1.19	1.33
ly	1,815	595	931	.847	.976
gust	2,043	640	1,045	.951	1.10
ptember	1,033	430	573	.521	.581
tober	430	320	369	.336	.387
ovember	930	355	588	.535	.597
ecember	1,890	510	869	.791	.912
The year	9,130	320	1,131	1.03	14.01

HOLSTON RIVER (SOUTH FORK) AT BLUFF CITY, TENN.

This station was originally established by the United States Weather Bureau at the highway bridge at Bluff City, Tenn. Readings were begun July 17, 1900, by the United States Geological Survey in connection with the general hydrographic investigation of the Southern Appalachian region. The gage, which is the property of the United States Weather Bureau, is a 4 by 8 inch timber bolted to the downstream side of the first channel pier from the right bank. The gage readings are furnished by the United States Weather Bureau. Discharge measurements are made from the lower side of the four-span highway bridge to which the gage is attached. This bridge is a short distance below the Virginia and Southwestern Railroad bridge. The initial point for soundings is the end of the guard rail on the downstream side of the bridge over the left abutment. The channel is straight above the bridge for a distance of 300 feet, to the bridge of the Virginia and Southwestern Railroad. The channel is straight for about 1,000 feet below the bridge. The bed is rocky and permanent. The bottom is very rough, and rocky ledges just above and below the bridge cause back currents, eddies, and sudden variations in the velocity. Both banks are high and do not overflow. The gage is referred to a United States Geological Survey bronze bench-mark tablet set in the upstream side of the capstone of the left abutment. When the gage reads zero, this bench mark is 20.44 feet above the water surface. Its elevation above sea level is 1,389 feet.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Holston River (South Fork) at Bluff City, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 26	B. S. Drane	265	590	1.89	1.62	1,114
March 28	do	268	763	1.98	2.38	1,509
April 29	Drane and M. R. Hall	275	955	3.04	3.27	2,900
July 12	J. M. Giles	97	273	1.68	.60	459
July 12[a]	do	123	490	.97	.60	475
August 10	B. S. Drane	204	252	1.52	.60	384
October 18	do	196	181	.89	— .05	162
October 18	do	108	73	2.35	— .05	171
October 18[a]	do	112	349	.48	— .09	168

[a] Measurement made at Virginia and Southwestern Railroad bridge.

m daily gage height, in feet, of Holston River (South Fork) at Bluff City, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	0.30	0.70	1.60	1.65	2.40	0.90	1.80	0.40	0.00	0.10	−0.10	0.30
.....	.40	.20	1.80	1.60	2.10	.90	1.30	2.00	.20	.10	.00	.30
.....	.60	.50	2.00	1.45	2.00	1.00	1.00	1.60	.40	.10	.00	.40
.....	.30	.40	2.00	1.20	3.00	.90	.90	1.20	.60	.10	.10	.60
.....	.10	.10	1.90	1.20	2.85	.70	.80	.90	.70	.10	.30	.70
.....	.40	.40	1.70	1.10	2.30	.70	.70	1.00	.60	.10	.30	2.80
.....	.40	.50	1.70	1.10	1.95	.60	.70	.90	.40	.10	.20	1.80
.....	.40	1.90	3.20	1.25	1.75	.70	.60	.70	.20	.10	.20	1.30
.....	.40	2.00	3.00	1.10	1.90	.60	.60	.60	.20	.00	.10	.90
.....	.20	1.50	2.40	1.00	2.00	.60	.80	.60	.10	.00	.10	.80
.....	.10	1.40	2.10	1.00	2.00	.60	.80	.70	.20	.00	.10	.80
.....	.90	1.10	2.20	1.00	1.80	.60	.60	1.60	.20	.00	.00	.90
.....	.90	.80	1.90	1.10	1.60	.60	.50	1.20	.10	.00	.20	.80
.....	.90	.90	1.90	1.55	1.40	.50	.70	1.00	.10	.00	.50	.80
.....	.70	1.00	1.80	1.50	1.50	.50	.40	.80	.10	.00	.50	.50
.....	.60	1.00	1.75	1.50	1.45	.50	.30	.70	.10	−.10	.40	.60
.....	1.00	.80	1.50	1.40	1.20	.50	.90	.60	.10	−.10	.30	.60
.....	1.00	.50	1.65	1.10	1.10	.50	.50	.50	.10	−.10	.30	.60
.....	.90	.80	1.60	1.20	1.20	.50	.40	.50	.10	−.10	.30	.50
.....	.90	1.10	1.60	1.00	1.20	.40	.40	.80	.10	.00	.20	.50
.....	.80	1.10	1.55	1.00	1.20	.40	.30	.70	.10	−.10	.20	.40
.....	.80	1.60	1.80	1.00	1.10	.40	.30	.70	.10	−.10	.20	.40
.....	1.70	3.10	3.10	1.00	1.00	.40	.30	.70	.10	−.10	.40	.30
.....	1.80	2.40	5.70	.90	.90	.40	.40	.50	.10	−.10	.40	.30
.....	1.40	1.90	3.90	.90	.90	.30	.70	.40	.10	−.10	.40	.70
.....	1.30	1.60	3.00	.90	.80	.30	.60	.40	.00	.00	.30	.90
.....	1.10	1.60	2.75	2.00	.80	.40	.50	.40	.00	−.10	.20	.90
.....	.80	1.50	2.60	4.20	.70	.80	.60	.30	.10	.00	.10	2.00
.....	.70	1.50	2.10	3.60	.80	1.70	.50	.20	.10	−.10	.10	1.50
.....	.40	.....	2.00	2.90	.80	2.50	.50	.20	.10	−.10	.20	1.00
.....	.40	.....	1.70	.....	.80	.....	.40	.00	.....	−.10	.....	.90

ting table for Holston River (South Fork) at Bluff City, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.1	150	1.2	840	2.5	1,970	3.8	3,800
.0	190	1.3	910	2.6	2,080	3.9	3,980
.1	235	1.4	980	2.7	2,190	4.0	4,160
.2	280	1.5	1,060	2.8	2,310	4.2	4,530
.3	330	1.6	1,140	2.9	2,430	4.4	4,910
.4	380	1.7	1,220	3.0	2,550	4.6	5,310
.5	430	1.8	1,300	3.1	2,680	4.8	5,730
.6	485	1.9	1,390	3.2	2,820	5.0	6,180
.7	540	2.0	1,480	3.3	2,970	5.2	6,650
.8	595	2.1	1,570	3.4	3,120	5.4	7,130
.9	650	2.2	1,670	3.5	3,280	5.6	7,630
1.0	710	2.3	1,770	3.6	3,450	5.8	8,130
1.1	770	2.4	1,870	3.7	3,620	6.0	8,630

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1900 to 1904, inclusive. It is well defined tween gage heights −0.1 feet and 3.5 feet. The table has been extended beyond ese limits. Above gage height 5.4 feet the rating curve is a tangent, the difference ing 250 per tenth.

Estimated monthly discharge of Holston River (South Fork) at Bluff City, Tenn., for 1904.

[Drainage area, 828 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,300	235	573	0.692	0.798
February	2,680	235	885	1.07	1.15
March	7,880	1,060	1,860	2.25	2.59
April	4,530	650	1,086	1.31	1.46
May	2,550	540	1,115	1.35	1.56
June	1,970	330	550	.664	.741
July	1,300	330	515	.622	.717
August	1,480	190	579	.699	.806
September	540	190	274	.331	.369
October	235	150	185	.223	.257
November	430	150	291	.351	.392
December	2,310	330	651	.786	.906
The year	7,880	150	714	.862	11.75

HOLSTON RIVER AT AUSTINS MILLS, NEAR ROGERSVILLE, TENN.

This station is maintained in cooperation with the United States Weather Bureau, by whom the gage readings are furnished. It is located at the Southern Railway bridge at Austins Mills, Tennessee. The gage is graduated by feet and tenths to 49 feet, and is attached vertically to the downstream end of the pier nearest the right bank. It is read once each day by Fred Beal. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. This is a deck bridge, 800 feet long, resting on stone piers. Six spans are wooden truss, and piers have been built for two more spans at each end, but the track is carried on trestle work. The initial point for soundings is the end of the bridge truss over the center of the pier on the right bank, downstream side. The channel is straight for about 2,000 feet above and for 1,000 feet below the bridge. The current is swift, there being a shoal about 500 feet below the bridge. The right bank will overflow gradually at gage heights from 10 to 20 feet, and the left bank at gage heights 8 to 20 feet. There is a fringe of trees along both banks. The bed of the stream is composed of rock and gravel and is permanent. All the water passes beneath the bridge and trestles, there being one channel broken by three piers at ordinary stages.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

ischarge measurements of Holston River at Austins Mills, near Rogersville, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
ıly 14	J. M. Giles	376	1,526	1.17	1.75	1,783
ugust 12	B. S. Drane	420	1,591	1.47	2.00	2,332
ctober 21	do	413	1,229	.53	1.10	647

ean daily gage height, in feet, of Holston River at Austins Mills, near Rogersville, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	1.80	1.70	2.90	3.00	3.70	2.00	3.10	1.60	1.40	1.20	1.00	1.30
	1.50	1.60	3.10	2.90	3.30	2.70	2.80	1.60	1.40	1.20	1.00	1.30
	1.60	1.60	3.70	2.60	3.10	2.80	2.20	2.40	1.40	1.20	1.00	1.50
	1.60	1.50	3.10	2.40	3.00	2.40	2.10	2.30	1.80	1.20	1.10	1.60
	1.60	1.50	3.10	2.30	4.30	2.20	2.10	2.00	1.90	1.20	1.20	1.70
	1.70	1.50	2.90	2.30	3.60	2.20	2.10	2.00	1.60	1.20	1.30	3.10
	1.60	1.60	2.90	2.30	3.20	2.10	2.20	2.00	1.60	1.20	1.40	3.40
	1.60	2.00	5.00	2.30	2.60	2.10	2.10	1.90	1.50	1.10	1.30	2.60
	1.80	3.10	4.50	2.40	3.00	2.10	2.10	1.80	1.50	1.10	1.30	2.20
	1.60	2.80	3.90	2.40	3.40	2.00	2.00	1.80	1.40	1.10	1.20	2.00
	1.60	2.50	3.50	2.30	3.30	2.50	2.20	1.70	1.40	1.10	1.20	1.80
	1.70	2.20	3.40	2.20	3.10	2.20	2.00	1.70	1.40	1.10	1.20	1.80
	1.80	2.00	3.10	2.20	3.00	2.10	1.90	2.20	1.40	1.10	1.30	1.90
	2.00	1.80	3.10	2.40	2.70	1.90	1.80	2.00	1.40	1.10	1.30	1.80
	2.00	1.80	3.10	2.40	2.60	1.90	1.70	2.00	1.30	1.10	1.50	1.70
	1.80	1.80	3.10	2.40	2.50	1.80	1.70	2.10	1.30	1.10	1.50	1.70
	2.00	1.80	2.80	2.30	2.40	1.80	1.60	1.80	1.30	1.10	1.40	1.70
	2.20	1.70	2.60	2.40	2.30	1.80	1.50	2.00	1.30	1.10	1.30	1.60
	2.20	1.70	2.50	2.30	2.30	1.80	1.50	1.80	1.20	1.10	1.30	1.50
	2.00	2.10	2.50	2.20	2.20	1.80	1.50	1.90	1.20	1.10	1.30	1.50
	1.80	2.20	2.50	2.10	2.20	1.70	1.50	2.70	1.20	1.10	1.30	1.50
	1.80	2.20	3.20	2.00	2.20	1.70	1.50	2.60	1.20	1.10	1.30	1.50
	2.30	3.80	3.70	2.00	2.20	1.70	1.50	2.20	1.20	1.00	1.40	1.50
	3.40	3.80	7.00	2.00	2.20	1.70	1.50	1.80	1.20	1.00	1.40	1.40
	3.00	3.20	6.50	2.00	2.10	1.70	1.50	1.70	1.20	1.00	1.30	1.70
	2.50	3.00	5.00	2.00	2.10	1.70	1.70	1.60	1.20	1.00	1.50	1.80
	2.30	3.10	4.40	2.20	2.10	1.60	1.70	1.50	1.20	1.00	1.40	2.00
	2.20	3.30	4.10	3.70	2.00	1.80	1.70	1.50	1.20	1.00	1.30	2.80
	1.80	3.00	3.70	5.00	1.80	2.40	1.70	1.50	1.20	1.00	1.30	3.20
	1.70	.....	3.50	4.30	1.80	2.90	1.70	1.40	1.20	1.00	1.30	2.60
	1.70	.....	3.10	.....	1.80	.....	1.60	1.40	.....	1.00	.....	2.40

Rating table for Holston River at Austins Mills, near Rogersville, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.1	645	1.7	1,695	2.3	3,035	2.9	4,675
1.2	805	1.8	1,900	2.4	3,285	3	4,980
1.3	970	1.9	2,110	2.5	3,545	3.1	5,290
1.4	1,140	2	2,330	2.6	3,815	3.2	5,610
1.5	1,315	2.1	2,555	2.7	4,095	3.3	5,940
1.6	1,500	2.2	2,790	2.8	4,380	3.4	6,270

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1904 and one made in 1905. It is well defined between gage heights 1.1 feet and 2 feet. The table has been extended above these limits.

Estimated monthly discharge of Holston River at Austins Mills, near Rogersville, Tenn., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	6,270	1,315	2,273
February	7,590	1,315	3,169
March	18,150	3,545	7,007
April	11,550	2,330	3,704
May	9,240	1,900	4,096
June	4,675	1,500	2,460
July	5,290	1,315	2,093
August	4,095	1,140	2,125
September	2,110	805	1,077
October	805	490	636
November	1,315	490	952
December	6,270	970	2,325
The year	18,150	490	2,660

WATAUGA RIVER NEAR ELIZABETHTON, TENN.

This station was established May 11, 1903, by E. W. Myers, assisted by B. S. Drane. The station is located on the Virginia and Southwestern Railroad bridge at Siam, about 4 miles from Elizabethton, Tenn. The standard inclosed chain gage is located on the downstream side of the middle span on the inside of the guard rail. The zero of the scale is opposite a point 142 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 22.66 feet. It is read once each day by J. B. Nave. Discharge measurements are made on the lower side of the bridge to which the gage is attached. This bridge crosses the river at an angle of about 14° with the normal to the direction of the current. The initial point for soundings is the top of the first bolt on the downstream guard rail over the middle of the left abutment. The channel is straight for 1,000 feet above and below the station. The right bank is high and will overflow only at flood stages. All water will, however, pass under the bridge and the trestle approach. The left bank is a perpendicular masonry abutment and will not overflow. The section underneath the bridge is smooth and consists of sand, silt, and some small rocks, and does not appear to be shifting. At ordinary stages the channel is divided into three parts by the bridge piers. At flood stages there is an additional flood channel on the right bank. A shallow stretch 1,000 feet below the bridge makes the current under

dge sluggish at low stages. Bench mark No. 1 is a standard · bolt set in the cap of the abutment on the left bank, upstream the bridge. When the gage reads zero its elevation is 21.11 ove the water surface. Bench mark No. 2 is the upper edge plate connecting the lower bracing system with the lower chord or beam opposite the middle of the gage box on the downstream the bridge. This floor beam is the fourth from the left end middle span. When the gage reads zero its elevation is 19.60 ove the water surface. During the summer and fall of 1902 a f levels was run from Carter's station, Tennessee, near the of the river, to a point near Shulls Mills, in North Carolina, e head of the river, locating the water powers of this stream. powers are numerous and of considerable magnitude, but at t are comparatively inaccessible and hence not commercially le.

observations at this station during 1904 have been made under ection of M. R. Hall, district hydrographer.

ge measurements of Watauga River near Elizabethton, Tenn., in 1903 and 1904.

te.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
03.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
y 10	E. W. Myers	233	1,002	1.09	2.80	1,095
	do	229	762	.87	2.00	665
	B. S. Drane	228	662	.35	1.61	234
15	do	229	653	.31	1.38	205
15	M. R. Hall	205	620	.53	1.38	328
ber 5	B. S. Drane	228	633	.36	1.25	226
ber 5 [a]	do	108	369	.67	1.25	247
17	do	228	625	.33	1.20	204
ber 23	do	228	633	.34	1.26	214
04.						
y 25	B. S. Drane	229	788	.68	2.03	537
y 25	do	229	784	.65	2.01	507
25	do	234	1,183	2.12	3.70	2,507
)	do	230	751	.96	2.15	720
	J. M. Giles	189	594	.68	1.60	403
11	B. S. Drane	231	760	.99	2.13	754
19 [b]	do	109	311	.51	1.06	158
19	do	228	517	.30	1.06	156

[a] Boat three-fourths mile above station. [b] Boat one-half mile above station.

Mean daily gage height, in feet, of Watauga River near Elizabethton, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.50	2.35	2.05	2.10	2.50	2.00	2.20	1.40	1.15	1.05	1.25
2	1.30	1.70	2.60	2.00	2.00	3.00	1.80	2.20	1.70	1.15	1.05	1.30
3	1.25	1.60	2.30	2.00	2.70	2.30	1.70	2.10	1.60	1.15	1.10	1.35
4	1.25	1.50	2.30	1.90	3.70	2.20	1.60	2.00	1.50	1.15	1.20	1.35
5	1.20	1.40	2.15	1.80	2.70	2.10	2.70	1.60	1.60	1.15	1.50	1.60
6	1.15	1.60	2.00	1.75	2.40	2.00	1.90	1.75	1.50	1.10	1.50	2.30
7	1.20	1.50	4.45	1.80	2.20	2.20	1.70	1.75	1.45	1.10	1.30	1.80
8	1.20	2.70	3.90	1.70	2.90	1.95	1.60	1.70	1.40	1.10	1.20	1.50
9	1.20	2.20	3.10	2.20	3.50	1.80	1.50	1.65	1.30	1.10	1.15	1.40
10	1.20	1.90	2.60	1.90	3.00	1.80	1.70	1.50	1.30	1.10	1.10	1.50
11	1.30	1.80	2.80	1.85	2.80	1.80	1.60	2.15	1.25	1.10	1.10	1.60
12	1.50	1.65	2.30	1.90	2.50	1.80	1.60	1.90	1.25	1.10	1.10	1.60
13	1.50	1.65	2.30	1.80	2.40	1.70	1.55	1.70	1.30	1.10	1.40	1.50
14	1.40	1.65	2.20	1.70	2.20	1.70	1.50	1.65	1.30	1.10	1.45	1.50
15	1.20	1.70	2.15	1.70	2.25	1.60	1.45	1.70	1.35	1.10	1.50	1.40
16	1.35	1.70	2.10	1.80	2.10	1.50	1.40	2.60	1.30	1.10	1.50	1.40
17	1.80	1.60	2.00	1.85	2.00	1.60	1.40	2.00	1.25	1.10	1.45	1.40
18	1.70	1.60	1.95	1.75	2.60	1.60	1.40	1.70	1.20	1.10	1.45	1.35
19	1.70	1.60	2.00	1.70	2.40	1.50	1.40	1.60	1.20	1.10	1.40	1.35
20	1.40	1.70	2.00	1.70	2.10	1.50	1.30	1.60	1.20	1.05	1.35	1.30
21	1.50	1.70	2.00	1.65	2.00	1.60	1.30	2.00	1.20	1.05	1.35	1.30
22	1.70	2.15	2.35	1.65	1.90	1.70	1.40	1.80	1.15	1.05	1.40	1.30
23	3.00	2.40	4.00	1.60	1.80	1.60	1.50	1.60	1.15	1.05	1.40	1.30
24	2.10	2.20	5.20	1.60	1.75	1.50	1.55	1.50	1.15	1.05	1.40	1.30
25	1.90	2.05	4.00	1.55	1.90	1.45	1.85	1.50	1.15	1.05	1.35	1.50
26	1.90	2.00	3.10	1.65	1.35	1.45	1.80	1.45	1.15	1.05	1.35	1.60
27	1.50	2.60	2.85	1.90	1.30	1.50	1.50	1.45	1.15	1.05	1.30	1.65
28	1.50	2.75	2.60	2.30	1.20	1.70	1.60	1.45	1.15	1.05	1.30	1.70
29	1.55	2.40	2.40	2.30	1.20	2.80	1.50	1.40	1.15	1.05	1.30	1.65
30	1.40	.....	2.20	2.20	1.20	2.20	1.50	1.40	1.15	1.05	1.30	1.60
31	1.40	.....	2.10	.....	2.30	.....	1.60	1.40	.....	1.05	.....	1.60

Rating table for Watauga River near Elizabethton, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.0	135	2.0	650	3.0	1,530	4.0	3,025
1.1	170	2.1	720	3.1	1,645	4.2	3,390
1.2	210	2.2	790	3.2	1,765	4.4	3,770
1.3	250	2.3	865	3.3	1,895	4.6	4,160
1.4	295	2.4	945	3.4	2,035	4.8	4,560
1.5	345	2.5	1,030	3.5	2,180	5.0	4,960
1.6	400	2.6	1,120	3.6	2,335	5.2	5,360
1.7	460	2.7	1,215	3.7	2,500		
1.8	520	2.8	1,315	3.8	2,670		
1.9	585	2.9	1,420	3.9	2,845		

The above table is applicable only for open-channel conditions. It is based up 12 discharge measurements made during 1903 and 1904. It is not well defined. Th table has been extended above gage height 3.7 feet. This table is very uncerta above gage height 3.0 feet.

nthly discharge of Watauga River near Elizabethton, Tenn., for 1904.

[Drainage area, 408 square miles].

ıth.	Discharge in second-feet.			Run-off.	
	Maxtmum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
.....	1,530	190	372	0.912	1.05
.....	1,265	295	601	1.47	1.59
.....	5,360	618	1,357	3.33	3.84
.....	865	372	552	1.35	1.51
.....	2,500	210	873	2.14	2.47
.....	1,530	320	579	1.42	1.58
.....	1,215	250	417	1.02	1.18
.....	1,120	295	496	1.22	1.41
.....	460	190	254	.623	.695
.....	190	152	166	.407	.469
.....	345	152	258	.632	.705
.....	865	230	349	.855	.986
.....	5,360	152	523	1.28	17.48

DOE RIVER AT ELIZABETHTON, TENN.

n was established as a bench-mark station May 22, 1904, ıne. It is located at the covered wagon bridge in the ıbethton, Tenn. Discharge measurements are made from am side of the bridge by lowering the meter between the dge of the floor. The initial point for soundings is the l of the downstream hand rail. The channel is straight above and below the station. The current is extremely low water. Both banks are high and do not overflow. · passes between the stone abutments of the bridge. The ream is composed of sand, and is very shifting. There is ınel at all stages. A low dam about 300 feet below the affect the flow considerably at low stages. The bench :op of the lower downstream hand rail opposite the ten- he middle of the bridge, 65 feet from the initial point for Its elevation is 16 feet above gage datum.

ations at this station during 1904 have been made under of M. R. Hall, district hydrographer.

Discharge measurements of Doe River at Elizabethton, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 22	B. S. Drane	128	253	1.21	1.55	307
July 11	J. M. Giles	129	166	.60	.79	99
October 20	B. S. Drane	134	131	.37	.64	48

LITTLE TENNESSEE RIVER AT JUDSON, N. C.

This river rises in the extreme northeast Georgia, with tributaries from the mountains between North Carolina and Georgia, and flows in a northwesterly direction, emptying into Tennessee River at Lenoir, Tenn. Measurements of flow are made at Judson, N. C., below the mouth of Sawyer Branch. The area drained is mountainous and covered with forest growth. The station was established by E. W. Myers in June, 1896. It is located on the Southern Railway bridge, about one-fourth of a mile from Judson, N. C. The standard chain gage with inclosed scale is located on the downstream side of the first span from the left end of the bridge. The length of the chain from the end of the weight to the marker is 26.29 feet. The observer is J. L. Enloe, who reads the gage once daily. The river is straight for several hundred yards above and below the station; the bottom rocky and very rough on the west side and sandy on the east side. The current is swift and considerably obstructed by two wide timber piers. The section is constant, but not a good one for measurements.

Bench mark No. 1 is the top of the angle block on the lower chord at the middle of the first span from the left end of the bridge, on the downstream side. Its elevation is 23.36 feet above gage datum. Bench mark No. 2 is a standard copper bolt set in the rock near the end of the tunnel, on the right bank, 130 feet from the end of the bridge and 8 feet from the center of the track. Its elevation is 28.14 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

charge measurements of Little Tennessee River at Judson, N. C., in 1904.

e.	Hydrographer.	Area of section.	Mean. velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
.....	B. S. Drane.....	434	3.58	3.49	1,554
.....	.....do	303	3.27	2.95	993
5.....	.....do	311	3.07	2.98	955
er 30 ..	.....do	216	2.02	2.32	436
r 13...	.....do	249	2.33	2.53	580

laily gage height, in feet, of Little Tennessee River at Judson, N. C., for 1904.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	2.50	2.65	3.14	3.50	3.25	3.30	2.80	2.75	3.00	2.20	2.10	2.90
.....	2.52	2.61	3.08	3.50	3.15	3.20	2.75	2.80	3.10	2.20	2.30	2.80
.....	2.48	2.63	2.98	3.55	3.15	3.05	2.55	2.85	2.80	2.20	2.50	2.60
.....	2.42	2.48	3.09	3.40	3.20	2.95	2.50	2.75	3.00	2.20	2.60	2.60
.....	2.39	2.34	3.13	3.40	3.20	2.85	2.80	2.70	3.20	2.30	2.50	4.10
.....	2.43	3.18	4.20	3.35	3.25	2.80	2.60	2.95	2.80	2.20	2.30	[illegible]
.....	2.55	3.30	6.25	3.85	(a)	3.25	2.50	2.75	2.70	2.20	2.20	[illegible]
.....	2.52	3.32	5.15	4.00	(a)	3.30	2.50	3.10	2.70	2.20	2.20	[illegible]
.....	2.48	3.34	4.40	3.90	(a)	3.00	3.25	3.30	2.60	2.20	2.20	[illegible]
.....	2.45	3.28	4.19	3.65	(a)	2.90	2.75	3.20	2.60	2.20	2.20	2.70
.....	2.65	3.20	4.65	3.60	(a)	2.90	2.65	4.45	2.60	2.20	2.20	2.60
.....	2.58	2.81	4.25	3.60	(a)	2.90	2.65	3.70	2.50	2.20	2.60	2.60
.....	2.59	2.81	4.10	3.55	(a)	2.80	2.85	3.45	2.50	2.10	2.60	2.50
.....	2.52	3.48	3.90	3.55	3.30	2.75	2.60	3.10	2.50	2.10	2.60	2.50
.....	2.45	3.51	3.95	3.50	3.25	2.80	2.50	2.90	2.50	2.10	2.30	2.50
.....	3.28	3.22	3.85	3.45	3.20	2.65	2.45	2.85	2.50	2.10	2.30	2.50
.....	3.35	3.30	3.85	3.40	3.10	2.65	2.70	2.75	2.40	2.10	2.30	2.55
.....	3.22	3.28	3.80	3.35	3.15	2.75	2.80	2.70	2.40	2.10	2.20	2.45
.....	3.18	3.30	3.70	3.45	3.15	2.70	2.50	2.65	2.40	2.10	2.20	2.35
.....	2.84	3.80	3.65	3.40	3.10	2.90	2.45	2.60	2.40	2.10	2.20	2.10
.....	2.58	4.24	3.60	3.35	3.10	2.90	2.50	2.70	2.30	2.10	2.40	2.35
.....	5.30	5.38	4.72	3.30	3.05	3.00	3.00	2.65	2.40	2.10	2.60	2.35
.....	4.28	4.47	5.66	3.30	2.95	2.80	2.80	2.55	2.40	2.10	2.50	2.50
.....	3.22	4.13	5.12	3.25	2.90	2.70	2.70	2.90	2.30	2.10	2.30	2.50
.....	3.18	3.91	4.40	3.25	2.90	2.70	2.60	2.80	2.30	2.10	2.30	2.95
.....	2.59	3.63	4.10	3.20	2.95	2.80	2.50	3.00	2.30	2.10	2.20	2.80
.....	2.50	3.31	3.45	3.20	2.95	2.90	2.65	3.70	2.30	2.10	2.20	2.70
.....	2.42	3.14	3.45	3.15	2.90	2.70	2.60	3.50	2.40	2.10	2.60	4.70
.....	2.45	3.10	3.40	3.15	2.85	3.20	2.55	2.90	2.40	2.10	2.80	3.70
.....	2.81	.....	3.45	3.20	2.90	2.85	2.50	2.65	2.30	2.10	2.50	3.30
.....	2.71	.....	3.40	.....	3.50	.....	2.45	2.70	.....	2.10	.....	3.10

a Chain stolen.

Rating table for Little Tennessee River at Judson, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.2	335	3.4	1,580	4.6	3,580	6.6	8,050
2.3	405	3.5	1,720	4.7	3,780	6.8	8,540
2.4	485	3.6	1,860	4.8	3,980	7.0	9,050
2.5	575	3.7	2,000	4.9	4,180	7.5	10,460
2.6	675	3.8	2,140	5.0	4,380	8.0	12,200
2.7	775	3.9	2,300	5.2	4,820	8.5	14,200
2.8	875	4.0	2,460	5.4	5,260	9.0	16,200
2.9	985	4.1	2,620	5.6	5,700	9.5	18,450
3.0	1,100	4.2	2,800	5.8	6,140	10.0	20,700
3.1	1,220	4.3	2,980	6.0	6,580	11.0	25,500
3.2	1,340	4.4	3,180	6.2	7,070		
3.3	1,460	4.5	3,380	6.4	7,560		

The above table is applicable only for open-channel conditions. It is based upon 37 discharge measurements made during 1896 to 1904. It is well defined between gage heights 2.2 and 5 feet. The table has been extended beyond these limits. Above gage height 10 feet the rating curve is a tangent, the difference being 480 per tenth.

Estimated monthly discharge of Little Tennessee River at Judson, N. C., for 1904.

[Drainage area, 675 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	5,040	477	984	1.46	1.68
February	5,216	437	1,620	2.40	2.59
March	7,192	1,077	2,617	3.88	4.47
April	2,460	1,280	1,655	2.45	2.73
May	1,720	930	1,268	1.88	2.17
June	1,460	725	992	1.47	1.64
July	1,400	530	724	1.07	1.23
August	3,280	625	1,112	1.65	1.90
September	1,340	405	642	.951	1.06
October	405	275	300	.444	.512
November	875	275	472	.699	.780
December	3,780	275	964	1.43	1.65
The year	7,192	275	1,112	1.65	22.41

TUCKASEGEE RIVER AT BRYSON, N. C.

Tuckasegee River rises in the southwestern part of North Carolina, at the base of Tennessee Ridge, which separates Jackson and Transylvania counties. It flows in a northwesterly direction, emptying into Little Tennessee River at Bushnell, N. C. Measurements of discharge are made at Bryson, 2 miles below the mouth of Newton Mill Creek. The drainage area is largely rough and mountainous and covered with forest growth.

This station was originally established by E. W. Myers, June, 1896, at the Southern Railroad bridge, about 3 miles above Bryson, N. C., just below Governor Island post-office. This station was abandoned March 25, 1897, on account of the poor section. The present station was established November 7, 1897, by A. P. Davis, at the highway bridge in the town of Bryson, N. C., 2 miles below the mouth of Newton Mill Creek. The gage is a vertical rod bolted to the north pier on the right bank at the downstream side of the bridge. It is read once daily by J. M. Welch. Discharge measurements are made from the sidewalk on the downstream side of the single-span steel highway bridge. The initial point for soundings is the end of the hand rail at the left bank on the downstream side of the bridge. The channel is straight for about 600 feet above and below the station. The water is moderately swift, but the current is obstructed by the remnants of two old bridge piers. The right bank is low at the bridge and overflows to a slight extent, but all water passes beneath the bridge and its approach. The right bank is high and rocky and does not overflow. The bed is of gravel and sand and is fairly constant. Bench mark No. 1 is a copper bolt set in the stone sill beneath the large window in the northwest corner of D. K. Collins's brick store, about 80 feet east of the northeast corner of the county court-house. The window is on the side of the store nearest the court-house. The elevation of the bench mark is 22.32 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Tuckasegee River at Bryson, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 18	B. S. Drane	189	865	0.92	1.31	759
February 20	do	189	937	1.32	1.82	1,239
February 23	M. R. Hall	189	988	1.82	2.04	1,800
March 19	B. S. Drane	188	949	1.35	1.74	1,281
March 22	do	190	1,079	1.92	2.29	2,068
May 26	do	290	882	1.07	1.41	944
August 15	do	187	821	1.14	1.41	940
August 16	do	188	869	1.47	1.65	1,274
September 30	do	182	701	.65	1.00	456
October 1	do	182	701	.60	.98	422
October 12	do	182	730	.75	1.11	550
December 14	do	182	721	.70	1.05	502

Mean daily gage height, in feet, of Tuckasegee River at Bryson, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.10	1.20	1.85	1.90	1.60	1.70	1.45	1.40	1.30	1.00	0.85	1.10
2	1.20	1.10	1.70	1.80	1.60	1.70	1.35	1.40	1.50	1.00	.85	1.05
3	1.10	1.25	1.70	1.75	1.60	1.60	1.25	1.30	1.30	.95	1.00	1.30
4	1.00	1.10	1.65	1.70	1.55	1.50	1.40	1.30	1.40	.95	1.10	1.10
5	.90	1.15	1.50	1.70	1.50	1.40	1.30	1.40	1.50	.95	1.15	2.80
6	1.10	1.20	1.50	1.80	1.50	1.40	1.25	1.40	1.30	.95	1.05	1.70
7	1.10	1.90	4.80	2.60	1.50	2.00	1.20	1.80	1.20	.95	.90	1.40
8	1.05	2.00	2.65	2.40	3.90	1.70	1.20	1.40	1.20	.95	.90	1.30
9	1.00	1.60	2.30	2.10	2.60	1.60	1.60	1.40	1.20	.90	.90	1.15
10	1.10	1.50	2.05	1.95	2.10	1.45	1.35	2.00	1.20	.90	.90	1.25
11	1.25	1.50	2.10	1.85	1.90	1.50	1.35	2.00	1.25	.90	.90	1.20
12	1.10	1.40	1.90	1.80	1.80	1.40	1.30	1.70	1.15	.90	.90	1.15
13	1.25	1.30	1.80	1.75	1.80	1.35	1.20	1.50	1.15	.90	1.25	1.10
14	1.10	1.40	1.40	1.70	1.80	1.30	1.25	1.40	1.10	.90	1.10	1.05
15	1.10	1.40	2.00	1.70	1.70	1.30	1.15	1.40	1.10	.90	1.00	1.10
16	1.50	1.30	1.85	1.70	1.60	1.30	1.30	1.50	1.05	.90	.95	1.05
17	1.60	1.25	1.80	1.70	1.60	1.30	1.25	1.30	1.05	.90	.95	1.10
18	1.30	1.30	1.85	1.60	1.55	1.30	1.20	1.30	1.00	.90	.90	1.10
19	1.20	1.70	1.70	1.60	1.55	1.30	1.10	1.25	1.00	.90	.90	1.00
20	1.20	1.60	1.70	1.70	1.50	1.55	1.20	1.30	1.00	.85	.90	.95
21	1.20	2.00	2.10	1.70	1.50	1.30	1.30	1.20	1.00	.90	.90	1.00
22	5.40	2.80	2.10	1.60	1.45	1.50	1.40	1.20	1.00	.85	1.10	.95
23	1.90	2.00	3.70	1.55	1.40	1.30	1.40	1.30	1.00	.85	1.15	1.00
24	1.60	1.80	3.10	1.50	1.40	1.25	1.40	1.70	1.00	.85	1.00	1.20
25	1.60	1.70	2.70	1.50	1.40	1.25	1.40	1.50	1.00	.90	1.00	1.40
26	1.50	1.60	2.70	2.30	1.35	1.40	1.30	1.50	.95	.90	.90	1.30
27	1.35	2.00	2.60	1.80	1.35	1.30	1.20	1.60	.95	.90	.90	2.20
28	1.40	1.70	2.30	1.70	1.30	1.40	1.30	1.40	1.00	.85	.90	2.20
29	1.40	1.70	2.15	1.70	1.40	1.95	1.20	1.30	1.00	.85	.90	1.45
30	1.20	.....	2.10	1.70	1.60	1.50	1.20	1.25	1.00	.85	1.50	1.40
31	1.20	.....	2.00	.....	2.00	.....	1.20	1.25	.....	.85	.....	1.30

ting table for Tuckasegee River at Bryson, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.9	380	1.9	1,510	2.9	3,250	3.9	5,540
1.0	460	2.0	1,660	3.0	3,460	4.0	5,800
1.1	550	2.1	1,810	3.1	3,670	4.2	6,350
1.2	650	2.2	1,970	3.2	3,890	4.4	6,920
1.3	750	2.3	2,130	3.3	4,110	4.6	7,530
1.4	860	2.4	2,300	3.4	4,330	4.8	8,160
1.5	980	2.5	2,480	3.5	4,560	5.0	8,800
1.6	1,100	2.6	2,660	3.6	4,800	5.2	9,475
1.7	1,230	2.7	2,850	3.7	5,040	5.4	10,250
1.8	1,370	2.8	3,050	3.8	5,290		

The above table is applicable only for open-channel conditions. It is based prin-ally upon discharge measurements made during 1904. It is well defined.

Estimated monthly discharge of Tuckasegee River at Bryson, N. C., for 1904.

[Drainage area, 662 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
uary	10,250	380	1,026	1.55	1.79
bruary	3,050	550	1,103	1.67	1.80
rch	8,160	860	2,061	3.11	3.58
ril	2,660	980	1,378	2.08	2.32
y	5,540	750	1,286	1.94	2.24
ne	1,660	700	942	1.42	1.58
y	1,100	550	743	1.12	1.29
gust	1,660	650	921	1.39	1.60
ptember	980	420	586	.885	.986
tober	460	340	383	.579	.668
vember	980	340	457	.690	.770
cember	3,050	420	805	1.22	1.41
The year	10,250	340	974	1.47	20.03

HIWASSEE RIVER AT MURPHY, N. C.

The station was established July 26, 1896, by E. W. Myers. It is cated at the highway bridge, about 80 feet above the Atlanta, Knoxlle and Northern Railroad bridge and one-half mile above the mouth

of Valley River. The standard chain gage, with 24-inch box, clamped to the top of the downstream end of the first iron floorbe from the right bank in the space between the bridge floor and lower chords. The length of the chain from the bottom of the wei to the index is 27.05 feet. The gage is read once each day by Wil Mingus. Discharge measurements are made from the sidewalk on th upstream side of the single-span highway bridge. The bridge is 195 feet long, supported by stone abutments. The initial point for soundings is the end of the iron hand rail on the right bank, upstream side of the bridge. The channel is straight for about 500 feet above and below the station. The right bank is high and rocky and will not overflow. The left bank will overflow for a short distance around the abutment. The bed of the stream is rocky and rough and makes soundings uncertain. The bed is permanent and the flow is rapid.

Bench mark No. 1 is the downstream side of the top of the stone pier at the right bank, 22.55 feet above gage datum. Bench mark No. 2 is the top of the downstream end of the first iron floorbeam from the right end of the bridge; its elevation is 25.05 feet above gage datum. Bench mark No. 3 is a cut with large nail on a large white-oak tree in the grounds of the Atlanta, Knoxville and Northern Railroad station, on the left side of the street leading from the highway bridge to the town and 325 feet from the end of the bridge. Its elevation is 31.57 feet above gage datum. Bench mark No. 4 is a copper plug set in the solid rock on the right side of the river, 100 feet from the water's edge, 10 feet uphill from the foot of the hill and 500 feet up the river from the bridge. Its elevation is 21.31 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Hiwassee River at Murphy, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 22	M. R. Hall	172	562	3.55	6.63	1,996
February 24	do	168	441	2.58	6.00	1,138
March 1	O. P. Hall	168	392	1.69	5.54	661
March 2	do	168	386	1.67	5.54	644
May 12	do	168	403	1.87	5.66	754
June 29	do	167	366	1.75	5.53	639
August 29	do	164	318	1.08	5.10	344
October 6	do	156	259	.71	4.80	183
December 15	M. R. Hall	162	266	1.08	5.02	287

Mean daily gage height, in feet, of Hiwassee River at Murphy, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
.....	4.90	5.15	5.50	5.75	5.45	5.50	5.25	5.50	5.20	4.80	4.75	5.15
.....	4.90	5.10	5.50	5.70	5.40	5.35	5.10	5.20	5.10	4.80	4.75	5.00
.....	5.05	5.25	5.55	5.60	5.45	5.30	5.10	5.05	5.05	4.80	4.80	5.55
.....	4.95	5.10	5.55	5.55	5.45	5.25	5.05	5.05	5.30	4.80	5.00	5.15
.....	4.90	5.10	5.45	5.55	5.50	5.20	5.45	5.05	5.55	4.80	4.95	5.15
.....	4.85	5.10	5.40	5.50	5.45	5.15	5.10	5.65	5.15	4.80	4.90	5.95
.....	5.00	5.15	7.80	5.95	5.40	6.85	5.10	5.15	5.10	4.80	4.80	5.40
.....	4.85	6.00	6.60	6.50	5.55	5.65	5.05	5.85	5.05	4.80	4.80	5.15
.....	4.90	5.50	6.15	5.95	5.55	5.35	6.15	5.45	5.00	4.75	4.80	5.10
.....	4.90	5.45	5.90	6.05	6.05	5.25	5.25	5.25	5.00	4.75	4.80	5.15
.....	4.95	5.40	6.00	5.95	5.80	5.25	5.10	5.65	5.00	4.75	4.80	5.15
.....	5.05	5.35	5.75	5.80	5.70	5.35	5.10	5.45	4.95	4.75	4.80	5.00
.....	5.05	5.25	5.70	5.70	5.60	5.20	5.25	5.50	4.95	4.75	5.00	5.05
.....	5.10	5.20	6.25	5.65	5.55	5.15	5.10	5.25	4.95	4.75	5.00	5.05
.....	5.00	5.60	6.00	5.60	5.55	5.15	5.00	7.25	4.95	4.75	5.00	5.00
.....	5.00	5.40	5.75	5.65	5.45	5.10	5.00	5.45	4.90	4.75	4.90	5.00
17.....	5.70	5.30	5.70	5.55	5.45	5.10	5.35	5.25	4.90	4.75	4.80	5.05
18.....	5.35	5.25	5.65	5.55	5.45	5.10	5.35	5.15	4.90	4.75	4.80	5.05
19.....	5.20	5.25	5.60	5.50	5.40	5.10	5.00	5.10	4.85	4.75	4.85	5.05
20.....	5.15	6.05	5.50	5.45	5.35	5.65	4.95	5.45	4.85	4.75	4.85	5.00
21.....	5.10	5.70	5.50	5.60	5.35	5.30	4.95	5.20	4.95	4.75	4.80	4.95
22.....	5.20	6.55	6.50	5.45	5.30	5.20	5.20	5.10	4.90	4.75	4.90	4.95
23.....	6.30	6.40	7.40	5.40	5.30	5.15	5.05	5.10	4.90	4.70	4.90	4.95
24.....	5.70	6.00	7.35	5.40	5.30	5.10	5.05	5.50	4.85	4.75	4.95	5.00
25.....	5.45	5.75	6.80	5.40	5.25	5.05	5.15	5.35	4.85	4.75	4.85	5.25
26.....	5.35	5.60	6.35	5.40	5.25	5.25	5.00	5.10	4.85	4.75	4.85	5.15
27.....	5.25	5.60	6.35	5.75	5.25	5.60	4.95	5.60	4.85	4.75	4.85	5.10
28.....	5.20	5.50	6.10	5.60	5.20	5.10	4.95	5.30	4.85	4.80	4.80	6.45
29.....	5.20	5.45	6.00	5.55	5.20	5.85	5.05	5.15	4.85	4.80	4.80	5.65
30.....	5.05	.....	5.90	5.50	5.20	5.30	5.20	5.10	4.85	4.80	5.25	5.40
31.....	5.20	.....	5.80	.....	6.10	.....	4.95	5.10	.....	4.75	.....	5.30

Rating table for Hiwassee River at Murphy, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.8	190	5.6	710	6.4	1,690	7.2	3,130
4.9	235	5.7	800	6.5	1,850	7.3	3,330
5.0	285	5.8	900	6.6	2,020	7.4	3,540
5.1	340	5.9	1,010	6.7	2,190	7.5	3,750
5.2	400	6.0	1,130	6.8	2,370	7.6	3,960
5.3	470	6.1	1,260	6.9	2,550	7.7	4,180
5.4	540	6.2	1,400	7.0	2,740	7.8	4,400
5.5	620	6.3	1,540	7.1	2,930		

The above table is applicable only for open-channel conditions. It is based upon 59 discharge measurements made during 1900 to 1904, inclusive. It is well defined between gage heights 4.8 feet and 6.8 feet. The table has been extended above gage height 6.8 feet. Above gage height 7.6 feet the rating curve is a tangent, the difference being 220 per tenth.

Estimated monthly discharge of Hiwassee River at Murphy, N. C., for 1904.

[Drainage area, 410 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,540	212	401	0.978	1.13
February	1,935	340	671	1.64	1.77
March	4,400	540	1,303	3.17	3.66
April	1,850	540	777	1.90	2.12
May	1,260	400	605	1.48	1.71
June	2,460	312	532	1.30	1.45
July	1,330	260	380	.927	1.07
August	3,230	312	573	1.40	1.61
September	665	212	282	.688	.768
October	190	150	176	.429	.495
November	435	170	224	.546	.609
December	1,770	260	438	1.07	1.23
The year	4,400	150	530	1.29	17.62

HIWASSEE RIVER AT RELIANCE, TENN.

This station was established August 17, 1900, by O. P. Hall. It is located at the Atlanta, Knoxville and Northern Railroad bridge, near the ferry landing. The gage consists of a vertical rod, reading from zero to 10 feet, fastened to an oak tree on the right bank, 150 feet above the railroad bridge and 40 feet below the ferry landing, and a 5-foot section, reading from 10 to 15 feet, attached to a sycamore tree on the downstream side of the road leading to the ferry, about 400 feet from the river. The gage is read once each day by C. V. Higdon. Discharge measurements are made from the railroad bridge and from the wooden trestles on both banks. The railroad track is about 34 feet above low water. The initial point for soundings is the center of the heavy bolt or bridge pin, about 1 foot from the end of the bridge on the right bank, downstream side. This point is also at the center of the pier on the right bank. Above the station the channel makes a sharp bend to the east for a distance of 800 feet. Below the station the channel makes a sharp bend to the west for about 1,000 feet. At ordinary stages the river is about 350 feet wide at this point, and the section is a fairly good one. The water is held back by a ledge of rock below and is rather sluggish at low stages. Discharge measurements at low stages can be made at a ferry near Wetmore, 6 miles below. Both banks overflow, but all water passes beneath the bridge and its approaches.

ch mark No. 1 is a cut in a hickory tree on the right bank of the about 75 feet upstream from the bridge. Its elevation is 5.82 bove the zero of the gage. Bench mark No. 2 is the top of the stream iron girder under the cross-ties at a point about 40 feet the end of the bridge on the right bank. Its elevation is 23.90 bove the zero of the gage. Bench mark No. 3 is the top of the one of the right-bank pier on the upstream side of the bridge. evation is 19.26 feet above the zero of the gage. Bench mark is a copper plug set in a stone post flush with the surface of the d at the south end of C. V. Higdon's house, under the south w. This house stands on the right bank, about 50 feet up from ot of the hill, 600 feet north of the right-bank end of the bridge pposite a point on the river about 300 feet above the bridge. Its ion is 27.16 feet above the zero of the gage.

observations at this station during 1904 have been made under irection of M. R. Hall, district hydrographer.

Discharge measurements of Hiwassee River at Reliance, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
ry 24	O. P. Hall	332	2,197	1.45	2.32	3,177
ry 25	do	331	2,145	1.23	2.10	2,632
ry 25	M. R. Hall	304	2,017	1.36	2.10	2,735
3	O. P. Hall	308	1,968	.82	1.64	1,607
t 25	do	302	1,855	.55	1.30	1,012
t 26	do	302	1,864	.53	1.28	994
r 10	do	299	1,656	.25	.75	418

Mean daily gage height, in feet, of Hiwassee River at Reliance, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.30	1.80	2.40	1.65	1.90	1.50	1.10	1.10	0.80	0.75	1.20
2	1.00	1.40	1.80	2.00	1.60	1.60	1.25	1.50	1.20	.75	.75	1.30
3	1.10	1.40	1.70	1.90	1.60	1.45	1.15	1.25	1.05	.80	.75	1.60
4	1.30	1.30	1.70	1.85	1.30	1.45	1.10	1.50	1.00	.80	.85	1.50
5	1.40	1.30	1.70	1.80	1.20	1.40	1.10	1.15	1.45	.80	1.00	1.30
6	1.30	1.20	1.60	1.80	1.60	1.25	1.55	2.50	1.40	.78	1.00	2.50
7	1.40	1.20	2.20	2.00	1.55	1.30	1.20	1.60	1.15	.75	.90	1.70
8	1.10	2.10	3.20	2.10	1.30	1.85	1.15	1.65	1.05	.72	.85	1.40
9	1.10	2.00	2.50	2.80	3.20	1.55	1.10	1.45	1.00	.75	.85	1.30
10	1.00	1.70	2.10	2.30	2.30	1.40	1.40	1.50	.90	.75	.80	1.20
11	1.10	1.60	2.10	2.30	2.05	1.25	1.20	1.60	1.00	.75	.80	1.25
12	1.20	1.60	2.10	2.00	1.90	1.30	1.40	1.60	.95	.75	.80	1.20
13	1.30	1.50	1.90	2.00	1.80	1.35	1.50	1.45	.95	.75	.95	1.15
14	1.30	1.40	2.20	1.85	1.75	1.20	1.30	1.45	.92	.72	1.00	1.10
15	1.30	1.50	2.50	1.80	1.75	1.20	1.10	1.40	.90	.72	1.05	1.10
16	1.20	1.60	2.20	1.85	1.65	1.15	.90	2.10	.90	.72	.90	1.10
17	1.60	1.50	2.00	1.75	1.60	1.15	1.10	1.50	.85	.72	.85	1.10
18	1.80	1.50	1.90	1.75	1.60	1.15	1.12	1.35	.85	.72	.85	1.15
19	1.50	1.60	1.85	1.70	1.55	1.15	1.20	1.35	.80	.70	.85	1.15
20	1.40	2.30	1.80	1.65	1.50	1.15	.90	1.35	.80	.70	.85	1.15
21	1.30	2.00	1.80	1.70	1.50	1.50	.94	1.40	.90	.70	.85	1.05
22	1.70	2.70	3.10	1.70	1.45	1.40	1.40	1.25	.95	.70	.95	1.00
23	3.60	3.10	4.30	1.60	1.40	1.40	1.50	1.25	.85	.70	1.00	1.00
24	2.30	2.50	4.30	1.60	1.40	1.20	1.20	1.10	.90	.70	1.20	1.05
25	1.90	2.10	3.30	1.60	1.40	1.15	1.18	1.35	.80	.70	1.00	1.30
26	1.60	1.90	2.80	1.70	1.35	1.20	1.22	1.30	.80	.70	.90	1.35
27	1.50	1.80	2.80	2.20	1.35	1.30	1.15	1.10	.80	.75	.90	1.40
28	1.40	1.80	2.60	1.85	1.30	1.50	1.10	1.50	.80	.75	.85	2.50
29	1.40	1.80	2.40	1.80	1.30	1.60	1.40	1.30	.85	.75	.85	2.60
30	1.40	.....	2.20	1.75	1.30	1.70	1.15	1.20	.85	.75	1.20	1.70
31	1.30	.....	2.40	.....	1.60	.....	1.15	1.10	.....	.80	.....	1.50

Rating table for Hiwassee River at Reliance, Tenn., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.7	380	1.7	1,725	2.7	4,410	3.7	8,080
.8	460	1.8	1,940	2.8	4,745	3.8	8,475
.9	550	1.9	2,165	2.9	5,090	3.9	8,875
1.0	655	2.0	2,400	3.0	5,445	4.0	9,280
1.1	770	2.1	2,650	3.1	5,805	4.1	9,685
1.2	895	2.2	2,915	3.2	6,170	4.2	10,090
1.3	1,030	2.3	3,190	3.3	6,540	4.3	10,500
1.4	1,180	2.4	3,480	3.4	6,915		
1.5	1,345	2.5	3,780	3.5	7,300		
1.6	1,525	2.6	4,090	3.6	7,690		

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904 and 1 measurement made in 1901. It is well defined between gage heights 0.7 foot and 2.3 feet.

Estimated monthly discharge of Hiwassee River at Reliance, Tenn., for 1904.

[Drainage area, 1,180 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
y	7,690	655	1,402	1.19	1.37
ry	5,805	895	1,962	1.66	1.79
	10,500	1,525	3,563	3.02	3.48
	4,745	1,525	2,217	1.88	2.10
	6,170	895	1,635	1.39	1.60
	2,165	833	1,169	.991	1.11
	1,435	550	930	.788	.908
	3,780	770	1,280	1.08	1.24
ıber	1,263	460	625	.530	.591
r	460	380	412	.349	.402
ber	895	420	562	.476	.531
ber	4,090	655	1,281	1.09	1.26
The year	10,500	380	1,420	1.20	16.38

VALLEY RIVER AT TOMOTLA, N. C.

s station was established June 29, 1904, by M. R. Hall. It is d at a footbridge about 250 feet below a public road ford and ards from Tomotla, N. C., and 5 miles above Murphy, N. C. gage is a vertical timber 10 feet long, graduated to feet and s, fastened to a pine timber which is spiked to the upstream side naple tree on the right bank about 50 feet below the ford. It is once each day by J. T. Hayes. Discharge measurements are from the single-span footbridge, the floor of which is 10 to 15 bove low water. The initial point for soundings is the upstream of abutment next to the water on the right bank. The channel ight for about 500 feet above and for 1,000 feet below the station. urrent is moderately swift. Both banks are high and rocky, and ot liable to overflow. The bed of the stream is composed of but there is a fairly smooth and permanent section. There is ne channel at all stages. Bench mark No. 1 is a cross on the of a large spike driven into the downstream side of an elm tree 10 feet upstream from gage. Its elevation is 8.50 feet above ero of the gage. Bench mark No. 2 is a cross on a point of rock pring on right bank about 50 feet above the foot bridge. Its tion is 3 feet above the zero of the gage.

e observations at this station during 1904 have been made under irection of M. R. Hall, district hydrographer.

Discharge measurements of Valley River at Tomotla, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 13	O. P. Hall	58	145	1.42	1.76	206
June 29	do	57	117	.71	1.17	83
August 29	do	55	106	.70	1.12	74
October 6	do	55	88	.36	.80	32

Mean daily gage height, in feet, of Valley River at Tomotla, N. C., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.10	1.30	1.10	0.90	0.70	1.70	17	1.00	1.40	0.95	0.80	0.90	1.30
2	1.00	1.10	1.10	.90	.70	1.70	18	1.00	1.30	.95	.80	.90	1.20
3	.95	1.10	1.10	.90	.90	2.40	19	.95	1.20	.95	.75	.90	1.20
4	1.00	1.10	1.10	.90	.90	1.60	20	.95	1.20	.95	.75	1.00	1.20
5	1.20	1.10	1.10	.90	1.00	2.10	21	1.00	1.20	.95	.75	1.00	1.20
6	1.00	1.40	1.10	.90	1.00	2.00	22	1.40	1.20	.90	.75	1.00	1.20
7	1.00	1.10	1.10	.90	.90	1.80	23	1.10	2.00	.90	.75	1.00	1.20
8	1.00	1.40	1.10	.85	.90	1.60	24	1.10	1.40	.90	.75	1.00	1.90
9	1.30	1.20	1.00	.85	.90	1.60	25	1.10	1.30	.90	.75	1.00	1.60
10	1.10	1.20	1.00	.85	.90	1.60	26	1.10	1.30	.90	.75	1.00	1.50
11	1.00	1.20	1.00	.85	.90	1.60	27	1.00	1.30	.90	.75	1.00	2.20
12	1.20	1.10	1.00	.85	1.00	1.50	28	1.20	1.30	.90	.70	1.00	2.60
13	1.00	1.10	1.00	.80	1.00	1.50	29	1.00	1.20	.90	.70	1.00	2.00
14	1.00	1.10	.95	.80	1.00	1.40	30	1.00	1.20	.90	.70	2.30	1.60
15	.95	4.00	.95	.80	.90	1.30	31	1.00	1.10	.....	.70	.....	1.60
16	.95	2.00	.95	.80	.90	1.20							

Rating table for Valley River at Tomotla, N. C., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.7	22	1.2	88	1.7	192	2.2	327
.8	32	1.3	106	1.8	217	2.3	357
.9	44	1.4	126	1.9	243	2.4	388
1.0	57	1.5	147	2.0	270	2.5	420
1.1	72	1.6	169	2.1	298	2.6	452

The above table is applicable only for open-channel conditions. It is based upon four discharge measurements made during 1904. It is fairly well defined between gage heights 0.70 feet and 1.75 feet. The table has been extended above gage height 1.75 feet to 2.60 feet.

Estimated monthly discharge of Valley River at Tomotla, N. C., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
July	126	50	65.6
August	1,000	72	13.3
September	72	44	55.2
October	44	22	32.9
November	357	22	59.5
December	452	88	18.1

NOTTELY RIVER NEAR RANGER, N. C.

This station was established February 16, 1901, by O. P. Hall. It is located at the wooden wagon bridge one-half mile from the railroad station at Ranger, N. C., and one-fourth mile below the Atlanta, Knoxville and Northern Railroad bridge. The vertical gage is a 2-inch by 3-inch pine board in two sections, each 8 feet long, fastened to the left-hand side of the first wooden pier from the right bank. The gage is read once each day by A. D. Kilpatrick. Discharge measurements are made from the wagon bridge, a wooden structure of three spans supported by two wooden piers and two stone abutments; the center span is 55 feet long and the end spans are each 36 feet long. The floor of the bridge is about 20 feet above low water. The initial point for soundings is the inside face of the stone abutment on the right bank. The bridge is at a flat bend in the river, the channel curving slightly above and below the station for 600 feet. The right bank is high, rocky, and is somewhat wooded, and will overflow around the end of the bridge for about 50 feet only. The left bank is low and will overflow for a distance of 700 feet at a gage height of from 15 to 18 feet. The bed of the stream is of gravel and sand and probably shifts considerably. The current is somewhat broken and irregular, caused mostly by the piers. There is a moderate velocity and a depth of from 2 to 5 feet at low stages.

Bench mark No. 1 consists of the heads of large wire nails driven in the top of the downstream end of the wooden cap on the left bent of the wooden pier nearest the right bank of the river. Its elevation is 20.05 feet above the zero of the gage. Bench mark No. 2 is a cut on a maple tree 18 inches in diameter, 25 feet from the upstream side of the bridge on the right bank, 25 feet from the edge of the water. Its elevation is 15 feet above the zero of the gage. Bench mark No. 3 is a cut on red oak tree about 15 inches in diameter on the left bank

of the river, 35 feet from the end of the bridge near the downstream side of the road. Its elevation is 17.27 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Nottely River near Ranger, N. C., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
March 1	O. P. Hall	236	1.58	3.40	373
May 14	do	240	1.47	3.35	353
August 30	do	198	1.12	2.75	222
October 7	do	176	.69	2.30	121
December 16	M. R. Hall	190	.97	2.58	184

Mean daily gage height, in feet, of Nottely River near Ranger, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	3.00	3.40	3.80	3.30	3.30	2.90	3.40	2.70	2.30	2.20	2.80
2	2.80	2.90	3.40	3.70	3.30	3.30	2.70	3.00	2.60	2.30	2.20	2.40
3	2.80	2.90	3.30	3.60	3.30	3.00	2.50	2.80	2.60	2.30	2.20	2.40
4	2.70	3.40	3.30	3.50	3.30	2.90	2.40	2.80	2.70	2.20	2.40	2.80
5	2.70	3.20	3.30	3.40	3.30	2.90	2.40	3.60	4.10	2.20	2.30	4.10
6	2.60	3.00	3.20	3.30	3.20	2.80	2.90	3.00	3.00	2.20	2.30	3.60
7	2.80	3.00	8.30	4.20	3.20	7.30	2.70	2.80	2.80	2.20	2.30	3.10
8	2.70	4.50	5.10	5.60	3.30	4.70	2.70	5.00	2.70	2.20	2.30	3.00
9	2.70	3.60	4.50	5.00	4.60	3.70	3.00	3.50	2.60	2.20	2.30	2.90
10	2.60	3.20	4.00	4.50	3.90	3.00	2.80	3.10	2.50	2.20	2.30	2.80
11	2.60	3.30	4.00	4.00	3.70	2.90	2.60	4.00	2.60	2.20	2.30	2.80
12	2.60	3.30	3.80	3.80	3.40	3.00	3.10	3.80	2.60	2.20	2.30	2.80
13	2.50	3.10	3.30	3.70	3.40	2.90	2.20	3.40	2.50	2.20	2.40	2.70
14	2.50	3.00	4.40	3.60	3.30	2.70	2.70	2.90	2.50	2.20	2.40	2.60
15	2.70	3.30	4.00	3.60	3.30	2.70	2.60	3.90	2.40	2.20	2.40	3.00
16	2.80	3.10	3.70	3.50	3.10	2.70	2.40	3.10	2.30	2.20	2.40	2.90
17	4.00	3.00	3.70	3.40	3.10	2.70	2.60	2.90	2.30	2.20	2.40	2.80
18	3.20	3.00	3.70	3.50	3.10	2.70	2.60	2.70	2.30	2.20	2.30	2.70
19	3.80	3.00	3.60	3.50	3.10	2.60	2.50	2.70	2.30	2.20	2.30	2.70
20	3.00	4.80	3.40	3.50	3.10	2.70	2.40	2.70	2.30	2.20	2.30	2.70
21	3.00	3.80	3.30	3.40	3.00	2.90	2.40	2.70	2.20	2.20	2.30	2.70
22	3.00	5.60	5.40	3.40	3.00	3.00	4.20	2.70	2.20	2.20	2.30	2.60
23	5.00	5.00	6.70	3.40	3.00	2.80	2.80	2.60	2.20	2.20	2.30	2.50
24	4.00	4.30	6.40	3.30	2.90	2.70	2.60	3.50	3.00	2.20	2.20	2.70
25	3.80	3.80	5.20	3.30	3.00	2.70	3.10	2.90	2.60	2.20	2.20	2.80
26	3.40	3.70	5.10	3.80	2.90	2.70	2.80	2.80	2.30	2.20	2.20	2.80
27	3.20	3.60	5.00	3.70	2.90	2.80	2.60	2.70	2.30	2.20	2.20	2.80
28	3.00	3.50	4.50	3.70	2.90	3.20	2.80	3.20	2.30	2.20	2.20	4.70
29	3.00	3.30	4.10	3.40	2.90	4.60	2.60	2.70	2.30	2.20	2.20	3.40
30	3.00	.....	4.00	3.40	5.40	3.20	2.60	2.70	2.30	2.20	3.00	3.10
31	2.80	.....	3.90	.....	3.80	.....	2.60	2.70	.....	2.20	.....	3.00

ating table for Nottely River near Ranger, N. C., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.2	101	3.1	295	4.0	560	4.9	848
2.3	120	3.2	320	4.1	592	5.0	880
2.4	141	3.3	346	4.2	624	5.2	944
2.5	162	3.4	373	4.3	656	5.4	1,008
2.6	184	3.5	402	4.4	688	5.6	1,072
2.7	206	3.6	432	4.5	720	5.8	1,136
2.8	228	3.7	464	4.6	752	6.0	1,200
2.9	250	3.8	496	4.7	784	7.0	1,520
3.0	272	3.9	528	4.8	816		

The above table is applicable only for open-channel conditions. It is based upon 3 discharge measurements made during 1901 to 1904, inclusive. It is well defined etween gage heights 2.25 feet and 3.50 feet. The table has been extended beyond ese limits. Above gage height 3.60 feet the rating curve is a tangent, the differ- ice being 32 per tenth.

Estimated monthly discharge of Nottely River near Ranger, N. C., for 1904.

[Drainage area, 272 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
nuary	880	162	293	1.08	1.24
bruary	1,072	250	423	1.56	1.68
arch	1,936	320	656	2.41	2.78
ril	1,072	346	472	1.74	1.94
ay	1,008	250	362	1.33	1.53
ne	1,616	184	334	1.23	1.37
ly	624	101	210	.772	.890
ugust	880	184	310	1.14	1.31
ptember	592	101	174	.640	.714
ctober	120	101	103	.379	.437
ovember	272	101	124	.456	.509
ecember	784	141	264	.971	1.12
The year	1,936	101	310	1.14	15.52

OCOEE RIVER AT M'CAYS, TENN.

This station was established March 21, 1903, by O. P. Hall, and was permanently equipped by M. R. Hall on May 13, 1903. It is located at a suspension footbridge just below McCays's ferry at McCays, Tenn., near the Georgia-Tennessee boundary and one-half mile below the railroad bridge of the Atlanta, Knoxville and Northern Railroad. The gage is in two sections, the inclined section reading from −0.3 to 8.5 feet, and consists of double 2 by 6 inch timbers, spiked and bolted together, set in a trench and held in place by 2 by 6 inch posts driven into the ground and bolted or spiked to the gage. The vertical section, reading from 8 to 18 feet, is attached to the bridge posts on the right bank. Discharge measurements are made from the suspension footbridge, consisting of four wire cables and a plank footway. Its span is about 230 feet and it is 23 feet above the water surface at the end supports and 17 feet above the water surface at the middle. The initial point for soundings is the center of the high bent supporting the bridge on the left bank. The channel is practically straight for about 800 feet above and below the station. The right bank will overflow at about 14 feet gage height for about 500 feet; the left bank will overflow at gage height 12 to 20 feet for about 400 feet. The water is confined to one channel and the bed is probably constant. The current is good and the section is excellent.

Bench mark No. 1 is a cut on a walnut tree on the downstream side of the road, about 50 feet from the left-bank landing of McCays's ferry; its elevation is 12.59 feet above the zero of the gage. Bench mark No. 2 is the head of a large nail in the center of a post at the right-bank end of the footbridge, on the downstream side; its elevation is 16.10 feet above the zero of the gage. This post is an anchor post for the cable of the suspension bridge and may be pulled out of place. Bench mark No. 3 is a copper plug set in solid rock at the outer edge of the side ditch of the railroad bed, about 800 feet west of the railroad station at McCays. It is 11 feet north of the center of the track and is slightly higher than the railroad. Its elevation is 20.98 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Ocoee River at McCays, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per. sec.*	*Feet.*	*Second-ft.*
bruary 22	Hoyt and M. R. Hall	155	722	2.30	2.80	1,664
bruary 25	O. P. Hall	150	504	1.39	1.40	701
bruary 26	do	150	489	1.37	1.30	669
ly 11	do	148	488	1.29	1.33	629
ne 30	do	140	400	.96	.82	386
gust 26	do	134	369	.96	.65	354
tober 10	do	128	303	.71	.30	214

Mean daily gage height, in feet, of Ocoee River at McCays, Tenn., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	0.60	0.90	1.10	1.50	1.20	1.45	0.75	1.60	0.60	0.30	0.30	0.60
	.60	.80	1.20	1.50	1.25	1.20	.70	.95	.55	.30	.30	.85
	.70	.90	1.20	1.40	1.25	1.00	.70	.75	.55	.35	.40	1.05
	.60	.90	1.20	1.35	1.30	1.00	.65	.75	.55	.35	.50	.60
	.60	.80	1.00	1.30	1.20	.90	.90	1.00	.70	.30	.50	1.85
	.60	.80	1.00	1.35	1.10	.90	.80	.95	.60	.30	.40	1.40
	.70	.80	3.00	1.90	1.10	2.10	.70	1.10	.50	.30	.35	.75
5	.60	1.80	2.00	2.30	1.95	1.20	.75	1.70	.50	.30	.30	.60
6	.60	.90	1.60	2.10	1.80	.90	.90	1.25	.50	.30	.30	.50
7	.60	1.00	1.50	1.70	1.45	.90	.75	1.05	.50	.30	.30	.60
8	.80	1.20	1.60	1.65	1.30	.85	.70	1.45	.45	.30	.30	.55
9	.70	1.00	1.45	1.55	1.25	.90	1.20	1.10	.45	.30	.35	.50
10	.70	.90	1.30	1.50	1.20	.85	1.00	1.20	.45	.30	.55	.50
11	.70	.90	2.35	1.40	1.20	.80	.75	.95	.45	.30	.55	.40
12	.70	1.00	1.35	1.40	1.20	.80	.65	1.00	.40	.25	.50	.45
13	.70	.90	1.40	1.40	1.15	.75	.75	.85	.40	.25	.45	.40
14	1.30	.90	1.30	1.35	1.10	.75	.80	.75	.40	.25	.35	.55
15	1.00	.80	1.30	1.35	1.10	.70	.60	.70	.40	.25	.30	.50
16	.80	.90	1.30	1.30	1.10	.70	.60	.75	.40	.25	.30	.45
17	.70	2.00	1.30	1.25	1.15	.80	.55	.80	.35	.25	.30	.40
18	.70	2.00	2.25	1.30	1.00	.75	.60	.70	.40	.25	.35	.40
19	1.00	2.90	2.25	1.35	1.00	1.20	1.10	.60	.45	.25	.40	.40
20	1.70	2.20	3.60	1.25	1.00	.80	.75	.60	.40	.25	.65	.40
21	1.40	1.70	2.80	1.20	.90	.70	.70	.75	.35	.25	.40	.45
22	1.20	1.40	2.20	1.20	1.00	.65	.90	.70	.35	.25	.40	.75
23	1.10	1.30	1.95	1.35	.95	.70	.85	.70	.35	.30	.30	.60
24	.90	1.30	2.20	1.50	.90	.70	.65	.95	.35	.30	.30	1.50
25	1.00	1.20	1.85	1.35	.90	.70	1.00	.75	.40	.30	.30	2.25
26	.90	1.10	1.70	1.30	.90	1.20	.75	.65	.35	.30	.30	1.05
27	.90	.....	1.60	1.20	.90	.85	.70	.60	.30	.30	.75	.80
28	.80	.....	1.55	.....	2.35	.....	.75	.60	.....	.30	.....	.70

Rating table for Ocoee River at McCays, Tenn., from March 20, 1903, to December 31, 19

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.2	200	1.1	551	2.0	1,080	2.9	1,690
.3	230	1.2	602	2.1	1,145	3.0	1,760
.4	262	1.3	655	2.2	1,210	3.1	1,830
.5	296	1.4	710	2.3	1,275	3.2	1,900
.6	332	1.5	767	2.4	1,340	3.3	1,975
.7	370	1.6	826	2.5	1,410	3.4	2,050
.8	411	1.7	887	2.6	1,480	3.5	2,125
.9	455	1.8	950	2.7	1,550	3.6	2,200
1.0	502	1.9	1,015	2.8	1,620		

The above table is applicable only for open-channel conditions. It is based upo 15 discharge measurements made during 1903 and 1904. It is well defined betwee gage heights 0.25 feet and 3.4 feet. Above gage height 0.50 feet the rating table i the same as for 1903.

Estimated monthly discharge of Ocoee River at McCays, Tenn., for 1904.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	887	332	435
February	1,690	411	630
March	2,200	502	922
April	1,275	602	745
May	1,308	455	610
June	1,145	351	475
July	602	314	403
August	887	332	470
September	370	230	279
October	246	215	226
November	370	230	261
December	1,242	262	407
The year	2,200	215	488

FIGHTINGTOWN CREEK AT M'CAYS, TENN.

This station was established as a bench-mark station August 27, 1904, by O. P. Hall. It is located about one-half mile above the mouth of the creek, which flows into Ocoee River about one-half mile below the station on Ocoee River, at McCays, Tenn. Discharge measurements are made by means of a boat or by wading. Both banks are open,

cultivated lands, which will probably overflow. The bed is sandy and will no doubt change much. The bench mark is two small nails driven into the largest of a cluster of small maple sprouts on the right bank, 40 feet above the mouth of a small branch. Its elevation is 5 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Fightingtown Creek at McCays, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 12	O. P. Hall	40	119	1.03	[a] 1.25	122
August 27	do	40	107	.74	1.72	79
October 11	do	40	91	.44	1.12	40

[a] Gage height given is for the Ocoee River at McCays.

PAINT ROCK RIVER NEAR PAINTROCK, ALA.

This station was established as a bench-mark station February 4, 1904, by J. M. Giles. It is located at the highway bridge 2¾ miles south of Paintrock, Ala., and about 400 feet above the Southern Railway bridge. Discharge measurements are made from the upstream side of the single-span bridge, which is supported by tubular iron piers and has an approach of 12 feet at the right and 23 feet at the left bank. The initial point for soundings is the center of the upstream pier at the left bank. The channel is straight for about 200 feet above and 600 feet below the station. The current is sluggish. The right bank is low, wooded, and overflows during high water from one-fourth to one-half mile. The left bank is rocky, wooded, and overflows only under the approach. The bed of the stream is rocky, free from vegetation, and permanent. An old crib divides the stream into two channels at low stages. At high stages it is broken by the tubular steel piers. The bench mark is a point on the upstream end of the crossbeam 17 feet from the initial point for soundings. Its elevation is 20 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Paint Rock River near Paintrock, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 4	J. M. Giles	62	283	0.56	1.55	159
April 20	do	64	300	.92	2.00	275

FLINT RIVER AT BROWNSBORO, ALA.

This station was established as a bench-mark station February 5, 1904, by J. M. Giles. It is located at the highway bridge about one-fourth mile west of Brownsboro, Ala., and 100 feet below a 6-foot mill-dam. Discharge measurements are made from the downstream side of the single-span bridge, which is supported by tubular iron piers and has a trestle approach of 64 feet at each bank. The initial point for soundings is the center of the downstream pier at the left bank. The channel is straight for about 100 feet above and slightly curved for 500 feet below the station. The current is sluggish above and swift below the section. Both banks are high and clean. The left bank overflows during flood stages, forming a second channel about 500 feet east of the bridge. The bed of the stream is composed of clean sand and gravel, and is permanent. There is one channel at low and two at high stages. The channel at low and intermediate stages is broken by the piers and trestlework of the bridge. The bench mark is the top of the upstream pier at the left bank. Its elevation is 17 feet above gage datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Flint River at Brownsboro, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
February 5	J. M. Giles	120	395	0.53	1.70	209
April 29	do	127	411	.72	1.95	294

ELK RIVER NEAR ELKMONT, ALA.

This station was established June 24, 1904, by M. R. Hall. It is located at the wagon bridge near Wilson's store, about 5 miles east of Elkmont, Ala., and 3 miles below the bridge of the Louisville and Nashville Railway. A standard chain gage of the 24-inch boxed pattern is used. The box and scale are attached to the upstream lattice iron fencing of the bridge, about 125 feet from the right end. The length of the chain from the end of the weight to the marker is 36.45 feet. The gage is read once each day by J. S. Wilson. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. This bridge is of iron, with stone abutments and cylindrical iron piers, having a span of 82 feet at the right bank, a main span of 181 feet, and two spans of 82 and 20 feet, respectively, at the left bank. The initial point for soundings is the end of

the bridge downstream side at the right bank. Distances from the initial point are marked on the rail with white paint. The channel is nearly straight for about 1,500 feet above and straight for about 2,500 feet below the station. The current is swift. Both banks are high, cultivated, and liable to overflow. The bed of the stream is composed of rock, and is permanent. There is one channel broken by two piers at ordinary stage. Bench mark No. 1 is a point marked with white paint on the top of the downstream pier at the right bank. Its elevation is 31 feet above the datum of the gage. Bench mark No. 2 is a chisel mark on the intermediate post at the end of the gage box. Its elevation is 35 feet above gage datum. Bench mark No. 3 is a copper plug set in the upstream corner of the right abutment.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Elk River near Elkmont, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 21	J. M. Giles	213	605	2.23	2.62	1,352
May 17	do	205	482	1.65	2.15	794
June 24	do	170	498	1.39	2.02	690
August 17	do	221	518	1.53	2.10	795
October 20	do	188	335	.60	1.28	202
October 20	do	188	331	.59	1.27	194

Mean daily gage height, in feet, of Elk River near Elkmont, Ala., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	1.60	1.40	1.30	1.30	1.70	17	1.70	2.10	1.30	1.30	1.30	1.90
2	2.00	2.10	1.30	1.40	1.20	1.70	18	2.00	2.10	1.30	1.20	1.30	1.90
3	1.90	1.90	1.40	1.40	1.30	1.70	19	1.70	1.90	1.20	1.30	1.30	1.90
4	1.80	1.60	2.00	1.40	1.30	2.00	20	2.10	2.30	1.40	1.30	1.30	1.90
5	1.80	2.00	1.40	1.30	1.50	2.40	21	2.40	1.90	1.50	1.30	1.40	1.80
6	2.10	1.70	1.60	2.20	1.60	2.80	22	2.70	1.70	1.40	1.30	1.40	1.80
7	2.30	1.60	1.50	2.00	1.50	3.10	23	2.70	2.50	1.40	1.30	1.40	1.70
8	2.30	1.60	1.30	1.70	1.50	2.90	24	2.20	2.80	1.40	1.20	1.40	1.90
9	2.40	1.60	1.40	1.50	1.40	2.60	25	1.80	2.00	1.40	1.30	1.50	4.80
10	2.10	1.70	1.40	1.40	1.40	2.40	26	1.80	1.80	1.50	1.30	1.40	3.40
11	1.90	6.00	1.40	1.40	1.40	2.40	27	1.70	1.70	1.50	1.20	1.40	6.80
12	2.10	4.10	1.30	1.40	1.30	2.30	28	1.70	1.60	1.50	1.20	1.40	11.70
13	2.00	2.70	1.40	1.30	1.40	2.10	29	1.70	1.50	1.40	1.30	1.40	6.80
14	1.90	2.30	1.30	1.30	1.40	2.10	30	1.80	1.50	1.40	1.20	1.60	5.45
15	1.80	2.70	1.30	1.30	1.30	2.00	31	1.70	1.50	.....	1.20	.....	4.40
16	1.70	2.20	1.30	1.30	1.30	1.90							

Rating table for Elk River near Elkmont, Ala., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.2	165	1.7	468	2.2	870	2.7	1,475
1.3	220	1.8	538	2.3	975	2.8	1,620
1.4	278	1.9	612	2.4	1,090	2.9	1,775
1.5	338	2.0	690	2.5	1,210	3.0	1,940
1.6	401	2.1	775	2.6	1,340		

The above table is applicable only for open-channel conditions. It is based upon six discharge measurements made during 1904. It is well defined between gage heights 1.2 feet and 2.6 feet. The table has been extended above gage height 2.6 feet.

Estimated monthly discharge of Elk River near Elkmont, Ala.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
July	1,475	468	724
August	11,000	338	1,144
September	690	165	287
October	870	165	268
November	401	165	271
December, 1-24	2,115	468	860

BIG SPRING AT TUSCUMBIA, ALA.

This station was established as a bench mark-station July 20, 1903, by M. R. Hall. It is located at the ford just below the spring at Tuscumbia, Ala. Discharge measurements are made by wading, or from a buggy, at the lower side of the ford. There is no fixed initial point for soundings. The channel is nearly straight for about 1,000 feet below the station. The current is swift. Both banks are low and clean. The bed of the stream is composed of sand and gravel, with some moss on the bottom. The bench mark is the top of the fourth stone step from the top, left side, of the steps leading down to the spring. Its elevation is 8 feet above the datum.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Big Spring at Tuscumbia, Ala., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
April 22	J. M. Giles	46	70	1.43	2.15	100
August 15	do	45	48	.90	1.55	43
October 19	do	18	13.2	1.50	.70	20
October 19	do	16	12.4	1.50	.70	19

DUCK RIVER AT COLUMBIA, TENN.

This is an old Weather Bureau station which has not been maintained continuously. Two discharge measurements were made in 1901 by M. R. Hall. During 1904 discharge measurements have been made, and the gage heights have been regularly recorded since October 21, 1904.

It is located at the highway bridge two blocks north of the public square at Columbia, Tenn., three-fourths mile below a mill dam. Gage readings are made from the United States Weather Bureau gage, which is a vertical oak timber bolted to the downstream pier at the right bank. The gage reads by feet and tenths from 1 foot to 38 feet. A supplementary gage, graduated from −0.5 to 5 feet is spiked to a small willow tree on the left bank about 150 feet above the bridge. The gage is read twice each day by W. O. Cherry. Discharge measurements are made from the downstream side of the two-span bridge to which the gage is attached. The bridge consists of two spans, 199 feet and 97 feet long. Low-water measurements are made from a boat about one-fourth mile above the bridge. The initial point for soundings is the end of the bridge on the left bank, downstream side. The channel is curved for about 1,000 feet above and nearly straight for 2,000 feet below the station. The current is sluggish above and swift below the measuring section. Both banks are high and fringed with trees. The right bank overflows under the short span of the bridge during floods. The bed of the stream is composed of rock and gravel, free from vegetation and constant. There is one channel; all water passing under the left span at ordinary and under both spans at high stages.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Duck River at Columbia, Tenn., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 21	J. M. Giles	85	610	0.49	0.70	299
August 18	do	115	755	.38	.70	287
August 18	do	115	725	.39	.70	284
October 21	do	79	139	.94	.44	130
October 21	do	79	144	1.10	.40	158

Mean daily gage height, in feet, of Duck River at Columbia, Tenn., in 1904.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1		0.40	0.40	12		0.45	0.75	23	0.45	0.40	0.45
2		.35	.35	13		.45	.60	24	.50	.35	1.50
3		.30	.45	14		.45	.55	25	.45	.45	4.00
4		.40	.50	15		.50	.65	26	.40	.45	4.80
5		.55	.70	16		.35	.70	27	.40	.40	16.45
6		.50	1.35	17		.35	.55	28	.40	.45	15.25
7		.70	2.40	18		.35	.55	29	.40	.40	8.35
8		.60	1.60	19		.35	.55	30	.30	.40	4.45
9		.50	1.00	20		.30	.50	31	.40		3.15
10		.45	.95	21	0.45	.40	.50				
11		.45	.85	22	.50	.40	.50				

MISCELLANEOUS DISCHARGE MEASUREMENTS IN THE TENNESSEE RIVER DRAINAGE BASIN.

The following is a list of miscellaneous discharge measurements made in the Tennessee River drainage basin during 1904:

Roane Creek at Butler, Tenn.—This stream is an important tributary of Watauga River. A measurement was made March 26 at the county bridge crossing the creek about 600 feet above its mouth. The bench mark is the top of the downstream end of the second floor beam from the left bank, 25 feet above the datum of the gage.

Width, 82 feet; area, 188 square feet; mean velocity, 2.57 feet per second; gage height, 1.75 feet; discharge, 483 second-feet.

Watauga River at Watauga, Tenn.—A measurement was made July 13 from a bridge. The bench mark is the top of cross brace at the foot of the third post from the left end of the bridge, upstream side, 35 feet above the datum of the gage.

Width, 170 feet; area, 871 square feet; mean velocity, 0.68 foot per second; gage height, 2.70 feet; discharge, 594 second-feet.

Holston River (South Fork) near Bluff City, Tenn.—A measurement was made April 29 at the upper bridge, 9 miles above Bluff City, Tenn. The water surface was 23.10 feet below the bench mark.

Width, 182 feet; area, 632 square feet; mean velocity, 4.92 feet per second; discharge, 3,110 second-feet.

French Broad River at Alexander, N. C.—A measurement was made May 20 from the wagon bridge. The bench mark is the upper edge of the third band from the top on the upstream, left bank tubular pier, 5 feet above the datum of the gage.

Width, 223 feet; area, 992 square feet; mean velocity, 1.34 feet per second; gage height, 1.60 feet; discharge, 1,329 second-feet.

Pigeon River near Newport, Tenn.—Measurements were made at Deep Ford Bridge, 2 miles below Newport, Tenn., and 3 miles below the regular gaging station on Pigeon River, and 1½ miles above the mouth of the river.

March 29: Width, 198 feet; area, 913 square feet; mean velocity, 1.85 feet per second; gage height, 2.35 feet; discharge, 1,694 second-feet.

April 26: Width, 198 feet; area, 854 square feet; mean velocity, 1.07 feet per second; gage height, 1.68 feet; discharge, 915 second-feet.

July 8: Width, 179 feet; area, 768 square feet; mean velocity, 0.74 foot per second; gage height, 1.27 feet; discharge, 574 second-feet.

Clinch River at Clinton, Tenn.—A measurement was made August 8 from the ferryboat, 1,000 feet below the Southern Railway crossing at Clinton, Tenn. The gage height is from the gage of the United States Weather Bureau.

Width, 240 feet; area, 1,813 square feet; mean velocity, 0.61 foot per second; gage height, 3.90 feet; discharge, 1,109 second-feet.

Little Tennessee River at Franklin, N. C.—A measurement was made May 24 from the iron wagon bridge one-half mile east of Franklin, N. C., and 1 mile below the mouth of Cullasagee River. The bench mark is the upper edge of tie plate on the streamward side of the bottom of the first post from the right bank, 20 feet above the datum of the gage.

Gage height, 1.67 feet; discharge, 562 second-feet.

Little Tennessee River near Franklin, N. C.—A measurement was made May 24 from Iotla Bridge, 4 miles north of Franklin, N. C. The bench mark is the top of small plate tying the bottom of first post from the right bank to its floor beam, 22 feet above the datum of the gage.

Width, 131 feet; area, 271 square feet; mean velocity, 2.04 feet per second; gage height, 1.96 feet; discharge, 553 second-feet.

Nantahala River near Nantahala, N. C.—This stream is an important tributary of Little Tennessee River. A measurement was made October 8 from Matthew Cole's foot bridge, about 1 mile above Nantahala, N. C. The bench mark is the top of the left bent on the upstream side, 12 feet above the datum of the gage.

Width, 50 feet; area, 120 square feet; mean velocity, 0.96 foot per second; gage height, 0.82 foot; discharge, 115 second-feet.

Brasstown Creek at Brasstown, N. C.—This stream enters Hiwassee River about 5 miles above Murphy, N. C. A measurement was made May 13, at which time the gage on Hiwassee River at Murphy read 5.60 feet.

Width, 35 feet; area, 61 square feet; mean velocity, 1.34 feet per second; discharge, 82 second-feet.

Hanging Dog Creek near Murphy, N. C.—This creek enters Hiwassee River about 2 miles below Murphy. A measurement was made May 14, at which time the gage on Hiwassee River at Murphy read 5.60 feet.

Width, 33 feet; area, 54 square feet; mean velocity, 1.26 feet per second; discharge, 68 second-feet.

Sequatchie River near Jasper, Tenn.—This stream enters Tennessee River 5 miles south of Jasper, Tenn. A measurement was made February 9 from the highway bridge 2 miles northeast of Jasper, Tenn. The bench mark is the top of the downstream end of crossbeam 37 feet from the center of the right bank pier, 28 feet above the datum of the gage.

Width, 134 feet; area, 790 square feet; mean velocity, 2.32 feet per second; gage height, 8.30 feet; discharge, 1,829 second-feet.

Sequatchie River near Jasper, Tenn.—A measurement was made February 9 from the wagon bridge at Pregor's mill, 2 miles east of Jasper, Tenn. The bench mark is the top of the downstream end of crossbeam 37 feet from the left bank abutment, 28 feet above the datum of the gage.

Width, 170 feet; area, 1,036 square feet; mean velocity, 1.85 feet per second; gage height, 9.95 feet; discharge, 1,916 second-feet.

Battle Creek near South Pittsburg, Tenn.—This stream enters Tennessee River 1 mile east of Jasper, 1½ miles north of the Tennessee-Alabama State line. A measurement was made February 9 from the highway bridge on the road from South Pittsburg to Jasper. The bench mark is the top of the upstream end of crossbeam 56 feet from the right abutment, 25 feet above the datum of the gage.

Width, 67 feet; area, 276 square feet; mean velocity, 1.75 feet per second; gage height, 5.67 feet; discharge, 482 second-feet.

Toccoa River near Blueridge, Ga.—This stream is a tributary of Hiwassee River, its name becoming Ocoee River in the State of Tennessee. A measurement was made October 3 from a small boat, at Bench Leg Ford, 1 mile below the Morganton road bridge, and one-fourth mile below the mouth of Weaver Creek.

Width, 110 feet; area, 264 square feet; mean velocity, 0.65 foot per second; discharge, 172 second-feet.

Fightingtown Creek near Blueridge, Ga.—This stream is a tributary of Toccoa River. A measurement was made October 4 at the Galloway bridge, above the Horseshoe Bend.

Width, 33 feet; area, 25 square feet; mean velocity, 1 foot per second; discharge, 25 second-feet.

Flint River near New Decatur, Ala.—This stream enters Tennessee River from the south, near Decatur, Ala. A measurement was made May 16 from the bridge near New Decatur. The bench mark is the top of the downstream end of the crossbeam 67 feet from the left end of the bridge, 22 feet above the datum of the gage.

Width, 63 feet; area, 138 square feet; mean velocity, 0.45 foot per second; gage height, 2.45 feet; discharge, 62 second-feet.

Elk River near Prospect, Tenn.—This stream is an important tributary of Tennessee River, entering from the northeast, about 20 miles below Decatur, Ala. A measurement was made February 8 from the Louisville and Nashville Railroad bridge, three-fourths of a mile south of Prospect, Tenn. The bench mark is the base of rail, 150 feet from the right end of the bridge, 40 feet above the datum of the gage.

Width, 310 feet; area, 1,772 square feet; mean velocity, 2.99 feet per second; gage height, 2.70 feet; discharge, 5,296 second-feet.

Spring Creek at Tuscumbia, Ala.—This stream enters Tennessee River from the south near Tuscumbia, Ala. A measurement was made February 6 at the wagon bridge one-half mile northwest of the depot at Tuscumbia. The bench mark is the top of the upstream end of the crossbeam 18 feet from the right end of iron bridge, 20 feet above the datum of the gage.

Width, 70 feet; area, 201 square feet; mean velocity, 0.21 foot per second; gage height, 1.47 feet; discharge, 43 second-feet.

Big Bear Creek near Iuka, Miss.—This stream enters Tennessee River from the south, near the Alabama-Mississippi State line, about 5 miles northeast of Iuka. A measurement was made April 22 at the highway bridge, 5 miles east of Iuka. The bench mark is the top of the downstream right bank pier, 30 feet above the datum of the gage.

Width, 160 feet; area, 1,383 square feet; mean velocity, 0.48 foot per second; gage height, 7.10 feet; discharge, 670 second-feet.

YAZOO RIVER DRAINAGE BASIN.

Yazoo River rises in the northwestern part of Mississippi. It flows south just west of the central portion of the State and enters Mississippi River just above Vicksburg. The United States Geological Survey is maintaining a station on this river at Yazoo City, under the direction of M. R. Hall.

YAZOO RIVER AT YAZOO CITY, MISS.

A gage has been maintained at this point by the Engineer Corps of the Army. It was replaced in 1901 by a new gage rod in three sections, marked with brass figures and brass tacks, the sections being placed as follows: The lowest, marked from −3 to +4.5 feet, is attached to the protecting work of the bridge; the middle section, marked from 4.5 to 18.5 feet, is attached to the piling that protects the bridge pier; the uppermost section, continuing the graduation up to 32.3 feet, is on a post under the approach to the bridge. The highest known water occurred in 1882, reaching a gage height of 36.5 feet; the lowest occurred on October 15 to 17 and 20 to 22, 1896, with a gage height of −2.8 feet. The danger line is at 25 feet.

Discharge measurements are made from the highway bridge, consisting of one span of 85 feet, a turn-span of 190 feet, an approach on the right bank of about 100 feet, and on the left bank of about 1,200 feet. This is the bridge to which the gage is attached, and is located one-half mile northwest from the Illinois Central Railroad station in Yazoo City. The initial point for soundings is the end of the iron bridge on the left bank, downstream side. The channel is straight for about 3,000 feet above the station and is curved for about 2,000 feet below. The current is moderately rapid. As this stream is connected with the Mississippi River both above and below the station, it is influenced by the stage of that stream to the extent that high-water measurements are of no value. The bed is of sand and mud, and is subject to some change. The right bank is high, but overflows for a long distance at extreme floods; the left bank is high and overflows to the foot of the hill, about one-half mile from the river. There are trees along both banks.

A bench mark was established on the top of the upstream cylinder of the second pier from the left bank, at a distance of 85 feet from the initial point for soundings, which is on the downstream end of iron bridge on the left bank. The elevation of the mark is 35.85 feet above the zero of the gage. Other important bench marks in Yazoo City are the following: P. B. M. 12, Yazoo City, is a copper bolt in stone under ground, surmounted by an iron pipe and cap, in the north corner of the county court-house yard. It is 44.1 feet above the zero of the gage and 116.2 feet above mean sea level. P. B. M. 13, Yazoo City, is a copper bolt in stone under ground, surmounted by an iron pipe and cap, in the north corner of the public school yard, near Washington and Main streets. It is 29.2 feet above the zero of the gage and 101.3 feet above mean sea level. The observer is P. C. Battaille. Daily gage heights are furnished by the Weather Bureau.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Yazoo River at Yazoo City, Miss., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per sec.*	*Feet.*	*Second-ft.*
January 14	J. M. Giles	191	2,043	1.11	−0.55	2,261
August 11	do	223	2,929	1.73	3.00	5,054
October 27	do	183	1,656	.68	−3.15	1,122
October 27	do	183	1,639	.68	−3.15	1,120

Mean daily gage height, in feet, of Yazoo River at Yazoo City, Miss., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	3.50	0.00	15.40	22.30	5.50	10.70	6.00	−1.90	−2.80	−2.80	−2.50
2	2.50	3.70	.00	15.80	22.00	4.20	10.00	5.40	−1.90	−2.70	−2.80	−2.30
3	2.50	3.90	.00	16.20	21.80	3.00	9.50	4.00	−1.50	−2.60	−2.80	−2.00
4	2.50	4.00	.00	16.50	21.40	2.00	8.80	3.00	−1.30	−2.60	−2.80	−2.20
5	1.50	4.00	.00	16.80	21.00	1.40	8.30	2.50	−1.50	−2.60	−2.80	−2.20
6	1.00	4.00	.80	17.20	20.50	1.00	7.50	2.00	−1.70	−2.60	−2.80	−2.30
7	.90	4.00	1.40	17.60	20.00	1.00	7.00	1.90	−1.70	−2.60	−2.80	−2.40
8	.70	3.60	1.70	18.70	19.60	1.00	6.50	1.90	−1.90	−2.50	−2.80	−2.40
9	.50	3.40	2.00	18.70	19.00	2.00	6.40	2.00	−2.00	−2.60	−2.80	−2.40
10	.30	3.20	2.30	18.90	18.70	4.00	6.30	2.80	−2.00	−2.70	−2.80	−2.30
11	.00	3.00	2.60	19.10	18.30	5.50	6.00	3.00	−2.00	−2.70	−2.80	−2.20
12	−.30	2.50	2.90	19.40	18.00	6.80	6.30	3.40	−2.00	−2.70	−2.80	−2.00
13	−.50	1.50	3.20	19.80	17.80	7.90	5.80	3.70	−2.00	−2.80	−2.80	−1.90
14	−.60	1.00	3.30	20.00	17.70	8.80	5.50	4.10	−2.00	−2.80	−2.80	−1.80
15	−.60	.70	3.50	20.30	17.50	9.50	5.30	4.30	−2.10	−2.80	−2.80	−1.80
16	−.70	.50	3.80	20.60	17.40	10.30	5.40	4.20	−2.20	−2.80	−3.00	−1.80
17	−.80	.20	4.20	20.80	17.40	10.80	5.50	3.80	−2.20	−2.80	−3.00	−1.80
18	−.90	.00	5.30	21.10	17.30	11.30	6.20	3.50	−2.20	−2.80	−3.00	−1.80
19	−1.00	−.10	6.20	21.40	17.20	11.70	6.80	2.50	−2.20	−2.80	−3.00	−1.90
20	−1.10	−.10	7.00	21.60	17.00	12.00	7.50	2.00	−2.20	−2.80	−3.00	−1.80
21	−1.10	−.10	8.40	21.90	17.00	12.10	8.00	1.60	−2.30	−2.80	−3.00	−2.00
22	−1.10	−.10	9.10	22.00	16.50	12.30	8.30	1.00	−2.40	−2.80	−2.80	−2.10
23	−.10	−.10	9.90	22.20	16.10	12.50	8.50	.50	−2.40	−2.80	−2.80	−2.20
24	.00	−.10	10.80	22.40	15.60	12.40	8.70	−.10	−2.50	−2.80	−2.80	−2.20
25	.20	−.10	11.60	22.50	14.90	12.30	8.80	−.30	−2.60	−2.80	−2.80	−2.20
26	1.00	−.10	12.30	22.60	14.00	12.20	8.80	−.50	−2.70	−2.80	−3.00	−2.40
27	1.80	.00	14.00	22.60	12.90	12.00	8.80	−.80	−2.80	−2.80	−3.00	3.80
28	2.50	.00	14.10	22.60	11.50	12.00	8.80	−1.20	−2.80	−2.80	−3.00	4.20
29	3.00	.00	14.30	22.60	10.00	11.50	8.00	−1.40	−2.80	−2.80	−3.00	5.40
30	3.40	.....	14.70	22.50	8.50	11.30	7.50	−1.50	−2.80	−2.80	−3.00	7.50
31	3.50	.....	15.00	.....	7.00	.....	6.60	−1.80	.....	−2.80	.....	9.00

Rating table for Yazoo River at Yazoo City, Miss., from August 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−3.0	1,190	−2.2	1,534	−1.4	1,884	−0.6	2,239
−2.9	1,233	−2.1	1,577	−1.3	1,928	−0.5	2,284
−2.8	1,276	−2.0	1,620	−1.2	1,972	−0.4	2,329
−2.7	1,319	−1.9	1,664	−1.1	2,016	−0.3	2,374
−2.6	1,362	−1.8	1,708	−1.0	2,060	−0.2	2,419
−2.5	1,405	−1.7	1,752	−0.9	2,104	−0.1	2,464
−2.4	1,448	−1.6	1,796	−0.8	2,149	0.0	2,510
−2.3	1,491	−1.5	1,840	−0.7	2,194		

The above table is based upon 13 discharge measurements made during 1901 to 1904, and is well defined.

Estimated monthly discharge of Yazoo River at Yazoo City, Miss., for 1904.

[Drainage area, 8,580 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,245	2,016	2,856	0.333	0.384
February	4,520	2,464	3,294	.384	.414
August	5,800	1,708	3,516	.410	.473
September	1,928	1,276	1,555	.181	.202
October	1,405	1,276	1,302	.152	.175
November	1,276	1,190	1,244	.145	.162
December	8,220	1,405	2,273	.265	.306

Estimates March to July omitted, on account of probable back-water influence of Mississippi River on this station during portions of those months.

INDEX.

	Page.
Alderson, W. Va.	
Greenbrier River at:	
description	70–71
discharge	71
discharge, monthly	73
gage heights	72
rating table	72
Alexander, N. C.	
French Broad River at:	
description	155
discharge	155
Allegheny River at—	
Kittanning, Pa.:	
description	47
discharge	47
gage heights	47
Redhouse, N. Y.:	
description	45–46
discharge	46
gage heights	46
Allegheny River drainage basin:	
description	44–45
Ashville, N. C.	
French Broad River near:	
description	99–100, 100–101
discharge	100–101
Avery Creek at—	
Davisons River, N. C.:	
description	110–111
discharge	111
Battle Creek near—	
South Pittsburg, Tenn.:	
description	156
discharge	156
Big Bear Creek near—	
Iuka, Miss.:	
description	157
discharge	157
Big Spring at—	
Tuscumbia, Ala.:	
description	152
discharge	153
Biltmore, N. C.	
Swannanoa River at:	
description	104
discharge	104
Blacklick, Pa.	
Blacklick Creek at:	
description	50–51
discharge	51
gage heights	51
Blacklick Creek at—	
Blacklick, Pa.:	
description	50–51
discharge	51
gage heights	51
Blueridge, Ga.	
Fightingtown Creek near:	
description	157
discharge	157
Toccoa River near:	
description	156
discharge	156
Bluff City, Tenn.	
Holston River (South Fork) at and near:	
description	122, 154
discharge	122, 155
discharge, monthly	124
gage heights	123
rating table	123
Brasstown, N. C.	
Brasstown Creek at:	
description	156
discharge	156
Brasstown Creek at—	
Brasstown, N. C.:	
description	156
discharge	156
Brownsboro, Ala.	
Flint River at:	
description	150
discharge	150
Bryson, N. C.	
Tuckasegee River at:	
description	133
discharge	134
discharge, monthly	135
gage heights	134
rating table	135
Butler, Tenn.	
Roane Creek at:	
description	154
discharge	154
Calhoun, N. C.	
Little River at:	
description	111
discharge	111
Casselman River at—	
Confluence, Pa.:	
description	57–58
discharge	58
gage heights	58
Cataract, Ind.	
Eel River (lower) at:	
description	91–92
gage heights	92
Chadakoin River at—	
Jamestown, N. Y.:	
description	48
discharge	48
gage heights	49

Page.

Channahon, Ill.
Desplaines River near:
description 40–41
discharge 41
discharge, monthly 43
gage heights 42
rating table 43

Chattanooga, Tenn.
Tennessee River at:
description 107–108
discharge 108
gage heights 108

Cheat River near—
Morgantown, W. Va.:
description 52
discharge 53
gage heights 53

Chippewa River near—
Eau Claire, Wis.:
description 20
discharge 21
discharge, monthly 22
gage heights 21
rating table 22

Chippewa River drainage basin:
description 20

Clinch River at—
Clinton, Tenn.:
description 155
discharge 155

Clinton, Tenn.
Clinch River at:
description 155
discharge 155

Columbia, Tenn.
Duck River at:
description 153
discharge 154
gage heights 154

Columbus, Ohio.
Olentangy River near:
description 77
discharge 77
discharge, monthly 79
gage heights 78
rating tables 78–79
Scioto River near:
description 74
discharge 75
discharge, monthly 76
gage heights 75
rating table 76

Confluence, Pa.
Casselman River at:
description 57–58
discharge 58
gage heights 58
Laurel Hill Creek at:
description 58–59
discharge 59
gage heights 59
Youghiogheny River near:
description 56
discharge 57
gage heights 57

Page.

Cumberland River at—
Nashville, Tenn.:
description 96
discharge 97
gage heights 97

Cumberland River drainage basin:
description 96

Davidsons River, N. C.
Avery Creek at:
description 110–111
discharge 111
Davidsons River near:
description 109
discharge 109
gage heights 110

Davidsons River near—
Davidsons River, N. C.:
description 109
discharge 109
gage heights 110

Delphi, Ind.
Tippecanoe River near:
description 86
discharge 87
discharge, monthly 88
gage heights 87
rating table 88

Desplaines River near—
Channahon, Ill.:
description 40–41
discharge 41
discharge, monthly 43
gage heights 42
rating table 43

Doe River at—
Elizabethton, Tenn.:
description 129
discharge 130

Duck River at—
Columbia, Tenn.:
description 153
discharge 154
gage heights 154

Eau Claire, Wis.
Chippewa River near:
description 20
discharge 21
discharge, monthly 22
gage heights 21
rating table 22

Eel River (lower) near—
Cataract, Ind.:
description 91–92
gage heights 92

Elizabethton, Tenn.
Doe River at:
description 129
discharge 130
Watauga River near:
description 126–127
discharge 127
discharge, monthly 129
gage heights 128
rating table 128

Page.

Elk River near—
Elkmont, Ala.:
description 150-151
discharge..... 151
discharge, monthly 152
gage heights..... 151
rating table..... 152
Prospect, Tenn.:
description 157
discharge..... 157
Elkmont, Ala.
Elk River near:
description 150-151
discharge..... 151
discharge, monthly 152
gage heights..... 151
rating table..... 152
Fayette, W. Va.
New River at:
description 68-69
discharge, monthly 70
gage heights..... 69
Fightingtown Creek at and near—
Blueridge, Ga.:
description 157
discharge..... 157
McCays, Tenn.:
description 148-149
discharge..... 149
Flambeau River near—
Ladysmith, Wis.:
description 22-23
discharge..... 23
discharge, monthly..... 25
gage heights..... 24
rating table..... 24
Flint River at and near—
Brownsboro, Ala.:
description 150
discharge..... 150
New Decatur, Ala.:
description 157
discharge..... 157
Franklin, N. C.
Little Tennessee River at and near:
description 155
discharge..... 155
French Broad River at and near—
Alexander, N. C.:
description 155
discharge..... 155
Asheville, N. C.:
description 99-100, 100-101
discharge..... 100, 101
Horseshoe, N. C.:
description 98-99
discharge..... 99
gage heights..... 99
Newport, Tenn.:
description 101-102
discharge..... 102
discharge, monthly..... 103
gage heights..... 102
rating table..... 103
Oldtown, Tenn.:
description 101-102
discharge..... 102

Page.

French Broad River at and near—
Oldtown, Tenn.—Continued.
discharge, monthly 103
gage heights..... 102
rating table..... 103
Friendsville, Md.
Youghiogheny River at:
description 54
discharge 54
discharge, monthly..... 56
gage heights..... 55
rating table..... 55
Greenbrier River at—
Alderson, W. Va.:
description 70-71
discharge 71
discharge, monthly..... 73
gage heights..... 72
rating table 72
Greeneville, Tenn.
Nolichucky River near:
description 119-120
discharge..... 120
discharge, monthly..... 121
gage heights..... 120
rating table..... 121
Hanging Dog Creek near—
Murphy, N. C.:
description 156
discharge..... 156
Havana, Ill.
Illinois River near:
discharge..... 44
Hiwassee River at—
Murphy, N. C.:
description 135-136
discharge..... 136
discharge, monthly..... 138
gage heights..... 137
rating table..... 137
Reliance, Tenn.:
description 138-139
discharge..... 139
discharge, monthly..... 141
gage heights..... 140
rating table..... 140
Holston River near—
Rogersville, Tenn.:
description 124
discharge..... 125
discharge, monthly..... 126
gage heights..... 125
rating table..... 125
Holston River (South Fork) at and near—
Bluff City, Tenn.:
description 122, 154
discharge..... 122, 155
discharge, monthly..... 124
gage heights..... 123
rating table..... 123
Horseshoe, N. C.
French Broad River at:
description 98-99
discharge..... 99
gage heights.....

	Page.
Illinois River at and near—	
Havana, Ill.:	
discharge	44
Minooka, Ill.:	
description	35
discharge	35
discharge, monthly	37
gage heights	36
rating table	36
Ottawa, Ill.:	
description	37-38
discharge	38
gage heights	38
Peoria, Ill.:	
description	39
discharge	39
gage heights	40
Illinois River drainage basin:	
description	34
Indianapolis, Ind.	
White River (West Branch) at:	
description	89
discharge	89
discharge, monthly	91
gage heights	90
rating table	90
Iuka, Miss.	
Big Bear Creek near:	
description	157
discharge	157
Jamestown, N. Y.	
Chadakoin River at:	
description	48
discharge	48
gage heights	49
Jasper, Tenn.	
Sequatchie River near:	
description	156
discharge	156
Judson, N. C.	
Little Tennessee River at:	
description	130
discharge	131
discharge, monthly	132
gage heights	131
rating table	132
Kanawha River drainage basin:	
description	65-66
Kiskiminitas River at—	
Salina, Pa.:	
description	49-50
discharge	50
gage heights	50
Kittanning, Pa.	
Allegheny River at:	
description	47
discharge	47
gage heights	47
Knoxville, Tenn.	
Tennessee River near:	
description	104-105
discharge	105
discharge, monthly	107
gage heights	106
rating table	108
Ladysmith, Wis.	
Flambeau River near:	
description	22-23
discharge	23
discharge, monthly	25
gage heights	24
rating table	24
Laurel Hill Creek at—	
Confluence, Pa.:	
description	58-59
discharge	59
gage heights	59
Licking River at—	
Pleasant Valley, Ohio:	
description	63
discharge	63
discharge, monthly	65
gage heights	64
rating tables	64-65
Little Miami River drainage basin:	
description	80
Little River at—	
Calhoun, N. C.:	
description	111
discharge	111
Little Tennessee River at and near—	
Franklin, N. C.:	
description	155
discharge	156
Judson, N. C.:	
description	130
discharge	131
discharge, monthly	132
gage heights	131
rating table	132
Logansport, Ind.	
Wabash River at:	
description	83-84
discharge	84
discharge, monthly	86
gage heights	85
rating table	85
McCays, Tenn.	
Fightingtown Creek at.	
description	148-149
discharge	149
Ocoee River at:	
description	146
discharge	147
discharge, monthly	149
gage heights	147
rating table	148
Mad River near—	
Springfield, Ohio:	
description	80
discharge	81
gage heights	81
Mahoning River at—	
Youngstown, Ohio:	
description	60
discharge	60
discharge, monthly	62
gage heights	61
rating table	61
Mahoning River drainage basin:	
description	59-60

Merrill, Wis. Page.
Wisconsin River at:
description 25-26
discharge 26
discharge, monthly 28
gage heights 27
rating table 27
Mills River (North Fork) at—
Pinkbed, N. C.:
description 112
discharge 112
discharge, monthly 114
gage heights 113
rating table 113
Mills River (South Fork) near—
Sitton, N. C.:
description 114
discharge 115
discharge, monthly 116
gage heights 115
rating table 116
Minooka, Ill.
Illinois River near:
description 35
discharge 35
discharge, monthly 37
gage heights 36
rating table 36
Mississippi River near—
Sauk Rapids, Minn.:
description 18
discharge 19
gage heights 19
Monongahela River drainage basin:
description 51-52
Morgantown, W. Va.
Cheat River near:
description 52
discharge 53
gage heights 53
Murphy, N. C.
Hanging Dog Creek near:
description 156
discharge 156
Hiwassee River at:
description 135-136
discharge 136
discharge, monthly 138
gage height 137
rating table 137
Muskingum River drainage basin:
description 62
Nantahala, N. C.
Nantahala River near:
description 155
discharge 156
Nantahala River near—
Nantahala, N. C.:
description 155
discharge 156
Nashville, Tenn.
Cumberland River at:
description 96
discharge 97
gage heights 97
Necedah, Wis. Page.
Wisconsin River near:
description 28-29
discharge 29
discharge, monthly 31
gage heights 30
rating table 30
New Decatur, Ala.
Flint River near:
description 157
discharge 157
New River at—
Fayette, W. Va.:
description 68-69
discharge, monthly 70
gage heights 69
Radford, Va.:
description 66-67
discharge 67
discharge, monthly 68
gage heights 67
rating table 68
Newport, Tenn.
French Broad River near:
description 101-102
discharge 102
discharge, monthly 103
gage heights 102
rating table 103
Pigeon River at and near:
description 116-117, 155
discharge 117, 155
discharge, monthly 119
gage heights 118
rating table 118
Nolichucky River near—
Greeneville, Tenn.:
description 119-120
discharge 120
discharge, monthly 121
gage heights 120
rating table 121
Nottely River near—
Ranger, N. C.:
description 143-144
discharge 144
discharge, monthly 145
gage heights 144
rating table 145
Ocoee River at—
McCays, Tenn.:
description 146
discharge 147
discharge, monthly 148
gage heights 147
rating table 148
Oldtown, Tenn.
French Broad River at:
description 101-102
discharge 102
discharge, monthly 103
gage heights 102
rating table 103
Olentangy River near—
Columbus, Ohio:
description 77
discharge 77

Page.
Olentangy River near—
Columbus, Ohio—Continued.
discharge, monthly 79
gage heights..... 78
rating tables..... 78–79
Ottawa, Ill.
Illinois River at:
description 37–38
discharge..... 38
gage heights..... 38
Paint Rock River near—
Paintrock, Ala.:
description 149
discharge..... 149
Paintrock, Ala.
Paint Rock River near:
description 149
discharge..... 149
Peoria, Ill.
Illinois River near:
description 39
discharge..... 39
gage heights..... 40
Pigeon River at and near—
Newport, Tenn.:
description 116–117, 155
discharge..... 117, 155
discharge, monthly..... 119
gage heights..... 118
rating table 118
Pinkbed, N. C.
Mills River (North Fork) at:
description 112
discharge..... 112
discharge, monthly..... 114
gage heights..... 113
rating table 113
Pleasant Valley, Ohio.
Licking River at:
description 63
discharge..... 63
discharge, monthly 65
gage heights..... 64
rating tables..... 64–65
Prospect, Tenn.
Elk River near:
description 157
discharge..... 157
Radford, Va.
New River at:
description 66–67
discharge..... 67
discharge, monthly 68
gage heights..... 67
rating table 68
Ranger, N. C.
Nottely River near:
description 143–144
discharge..... 144
discharge, monthly 145
gage heights..... 144
rating table 145
Redhouse, N. Y.
Allegheny River at:
description 45–46
discharge..... 46
gage heights..... 46

Page.
Reliance, Tenn.
Hiwassee River at:
description 138–139
discharge..... 139
discharge, monthly 141
gage heights..... 140
rating table 140
Roane Creek at—
Butler, Tenn.:
description 154
discharge..... 154
Rock River at—
Rockton, Ill.:
description 31–32
discharge..... 32
discharge, monthly 34
gage heights..... 33
rating table..... 33
Rock River drainage basin:
description 31
Rockton, Ill.
Rock River at:
description 31–32
discharge..... 32
discharge, monthly 34
gage heights..... 33
rating table..... 33
Rogersville, Tenn.
Holston River near:
description 124
discharge..... 125
discharge, monthly 126
gage heights..... 125
rating table..... 125
Salina, Pa.
Kiskiminitas River at:
description 49–50
discharge..... 50
gage heights..... 50
Sauk Rapids, Minn.
Mississippi River near:
description 18
discharge..... 19
gage heights..... 19
Scioto River near—
Columbus, Ohio:
description 74
discharge..... 75
discharge, monthly..... 76
gage heights..... 75
rating table 76
Scioto River drainage basin:
description 74
Sequatchie River near—
Jasper, Tenn.:
description 156
discharge..... 156
Shoals, Ind.
White River (East Branch) at:
description 93
discharge..... 93
discharge, monthly..... 95
gage heights..... 94
rating table 95

Sitton, N. C. Page.
Mills River (South Fork) near:
description 114
discharge..... 115
discharge, monthly..... 116
gage heights..... 115
rating table 116
South Pittsburg, Tenn.
Battle Creek near:
description 156
discharge..... 156
Spring Creek at—
Tuscumbia, Ala.:
description 157
discharge..... 157
Springfield, Ohio.
Mad River near:
description 80
discharge..... 81
gage heights..... 81
Swannanoa River at—
Biltmore, N. C.:
description 104
discharge..... 104
Tennessee River at and near—
Chattanooga, Tenn.:
description 107-108
discharge..... 108
gage heights..... 108
Knoxville, Tenn.:
description 104-105
discharge..... 105
discharge, monthly 107
gage heights..... 106
rating table..... 106
Tennessee River drainage basin:
description 98
Tippecanoe River near—
Delphi, Ind.:
description 86
discharge..... 87
discharge, monthly..... 88
gage heights..... 87
rating table..... 88
Toccoa River near—
Blueridge, Ga.:
description 156
discharge..... 156
Tomotla, N. C.
Valley River at:
description 141
discharge..... 142
discharge, monthly..... 143
gage heights..... 142
rating table..... 142
Tuckasegee River at—
Bryson, N. C.:
description 133
discharge..... 134
discharge, monthly..... 135
gage heights..... 134
rating table..... 135
Tuscumbia, Ala.
Big Spring at:
description 152
discharge..... 153
Tuscumbia, Ala.—Continued. Page.
Spring Creek at:
description 157
discharge..... 157
Valley River at—
Tomotla, N. C.:
description 141
discharge..... 142
discharge, monthly..... 143
gage heights..... 142
rating table..... 142
Wabash River at—
Logansport, Ind.:
description 83-84
discharge..... 84
discharge, monthly..... 86
gage heights..... 85
rating table..... 85
Wabash River drainage basin:
description 82-83
Watauga, Tenn.
Watauga River at:
description 154
discharge..... 154
Watauga River at and near—
Elizabethton, Tenn.:
description 126-127
discharge..... 127
discharge, monthly 129
gage heights..... 128
rating table..... 128
Watauga, Tenn.:
description 154
discharge..... 154
White River (East Branch) at—
Shoals, Ind.:
description 93
discharge..... 93
discharge, monthly..... 95
gage heights..... 94
rating table 95
White River (West Branch) at—
Indianapolis, Ind.:
description 89
discharge..... 89
discharge, monthly..... 91
gage heights..... 90
rating table..... 90
Wisconsin River at and near—
Merrill, Wis.:
description 25-26
discharge..... 26
discharge, monthly..... 28
gage heights..... 27
rating table..... 27
Necedah, Wis.:
description 28-29
discharge..... 29
discharge, monthly..... 31
gage heights..... 30
rating table..... 30
Wisconsin River drainage basin:
description 25
Yazoo City, Miss.:
Yazoo River at:
description 158
discharge..... 1[illegible]

Yazoo City, Miss.—Continued. Page.
Yazoo River at—Continued.
discharge, monthly 160
gage heights 159
rating table 160
Yazoo River at—
Yazoo City, Miss.:
description 158
discharge..... 159
discharge, monthly 160
gage heights 159
rating table 160
Yazoo River drainage basin:
description 157
Youghiogheny River at and near—
Confluence, Pa.:
description 56
Youghiogheny River at and near— Page.
Confluence, Pa.—Continued.
discharge..... 57
gage heights 57
Friendsville, Md.:
description 54
discharge..... 54
discharge, monthly 56
gage heights 55
rating table 55
Youngstown, Ohio.
Mahoning River at:
description 60
discharge..... 60
discharge, monthly..... 62
gage heights..... 61
rating table..... 61

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PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 128.]

The publications of the United States Geological Survey consist of (1) Annual Reports; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of United States, folios and separate sheets thereof; (8) Geologic Atlas of United States, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

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3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they may be had at practically cost.

4. Copies of all Government publications are furnished to the principal public libraries in the large cities throughout the United States, where they may be consulted by those interested.

Series P.—The hydrographic progress reports contain the results of stream measurements. A report is issued for every calendar year, containing the results of data collected during that year. These reports were first published as a part of the Director's annual report or as a bulletin; they are now published as water-supply and irrigation papers. The following is a list, by years, of the publications containing the progress reports of stream measurements. A detailed index of these reports is published as Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.

1903. East of Mississippi River; Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124, 125, 126, 127, 128, and 129.
West of Mississippi River, Water-Supply Papers Nos. 130, 131, 132, 133, 134, and 135.

The Geological Survey and the Reclamation Service have suboffices in different parts of the United States, from which hydrographic and reclamation work in the respective localities is carried on and where data may be obtained on application. These offices are located as follows:

Boston, Mass., 6 Beacon street; Utica, N. Y., 75 Arcade; Atlanta, Ga., 409 Temple court; Austin, Tex., University of Texas; Chicago, Ill., Federal Building; Belle Fourche, S. Dak.; Cody, Wyo. Denver, Colo., Chamber of Commerce Building; Salt Lake, Utah; Los Angeles, Cal., 1108 Braly Building; San Francisco, Cal., 422 Merchants' Exchange Building; Phoenix, Ariz.; Carlsbad, N. Mex.; El Paso, Tex.; Billings, Mont.; Great Falls, Mont.; Hazen, Nev.; Boise, Idaho; Spokane, Wash., 424 Peyton Block; Pendleton, Oreg.

Correspondence should be addressed to

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